

Current tracking performance estimates

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Introduction

The basic tracking hardware configuration is settled now:

- MVTX = 3 layers of MAPS ladders (30 μm x 30 μm)
- INTT = 4 layers of silicon strip ladders (78 μm x 1 cm)
- TPC with 40 layers of readout GEMS from R = 30 cm to 78 cm

The simulation code implements the MVTX ladders using the Geant model provided by ALICE. The INTT ladder geometry is implemented in Geant 4 as it is presently envisioned by the RIKEN group.

The TPC is implemented as a 40 layer cylinder cell model, with the gas drift properties and readout performance parameterized to match the expected performance. A more realistic model is being worked on now. Space charge distortions + corrections are implemented in the simulation.

It was only very recently that the TPC simulation was changed from 60 layers to 40 layers. For that reason, many of the performance results shown here were obtained with the 60 layer TPC model. The momentum resolution is degraded by $\sim 5\%$ with 40 layers instead of 60.

Introduction (cont.)

Serious reorganization of the tracking code in the last few months:

- Track seeding using Hough transform code using (only) 7 TPC layers
 - Outside => in
 - Works fairly well, but a stop-gap measure until we make something better
- Track fitting using the Genfit package
 - State of the art Kalman filter package

The upgraded tracking code works pretty well now, although there are still features to be implemented, and some issues to be resolved. It has greatly improved performance over our earlier code, in particular for lower momentum tracks.

- The mass of the inner tracker is handled much better!

Outline

We present results for two tracking configurations:

MVTX + INTT + TPC (what we plan to build)

INTT + TPC

In each case we show tracking performance for low and high occupancy cases:

- 100 pion events and single Upsilon
- 100 pion events and Upsilon **embedded** in $b = 0-4$ fm Hijing events

The 100 pion events provide p_T resolution, DCA resolution, track efficiency
The Upsilon events provide Upsilon mass resolution

In the embedded case, The tracking performance is shown for the embedded tracks only.

Track Cuts

quality is a parameter based on the final track χ^2

dca2d is the track DCA in the bend plane referred to the event vertex

dcaZ is the track DCA in the Z direction referred to the event vertex

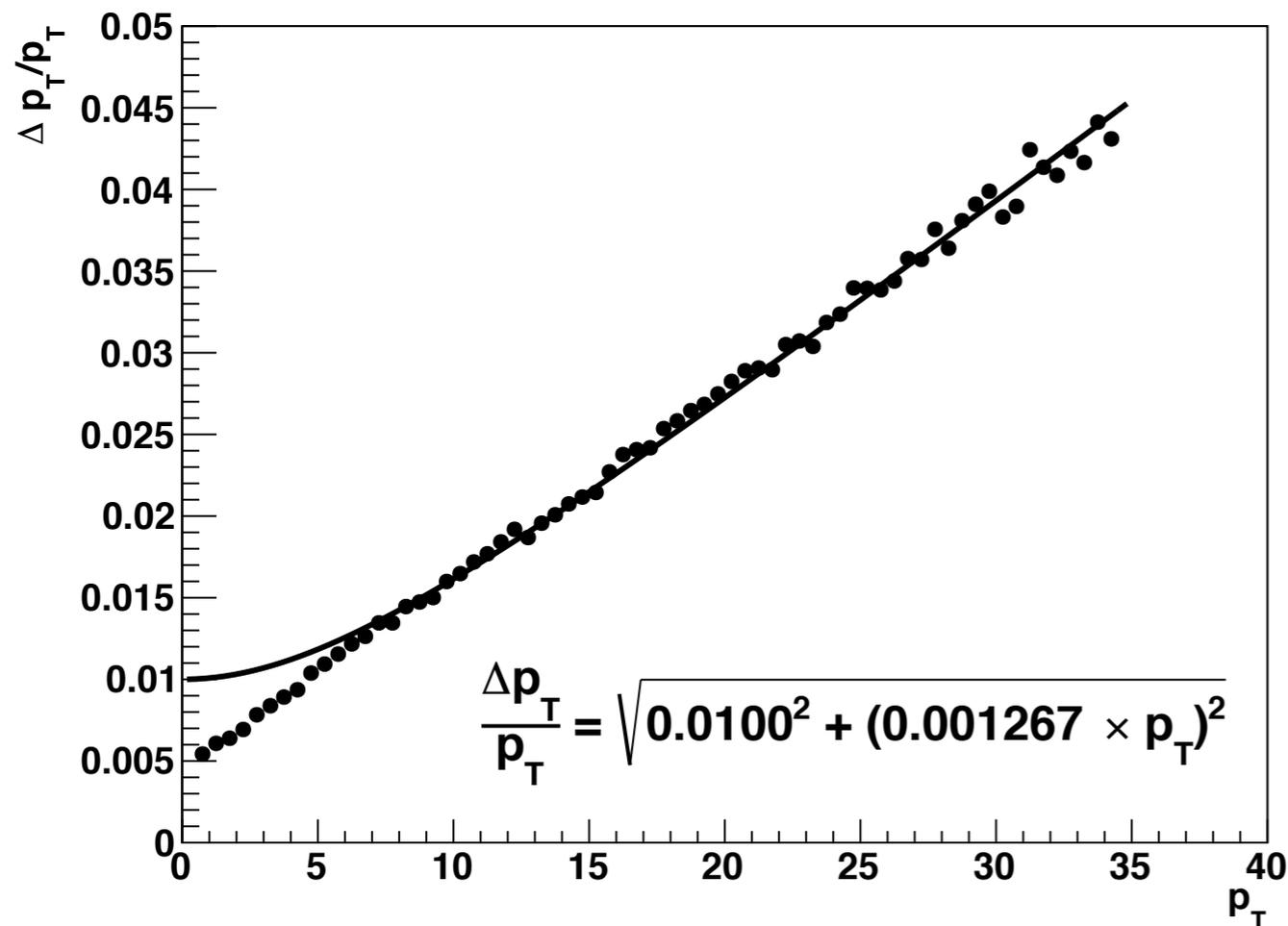
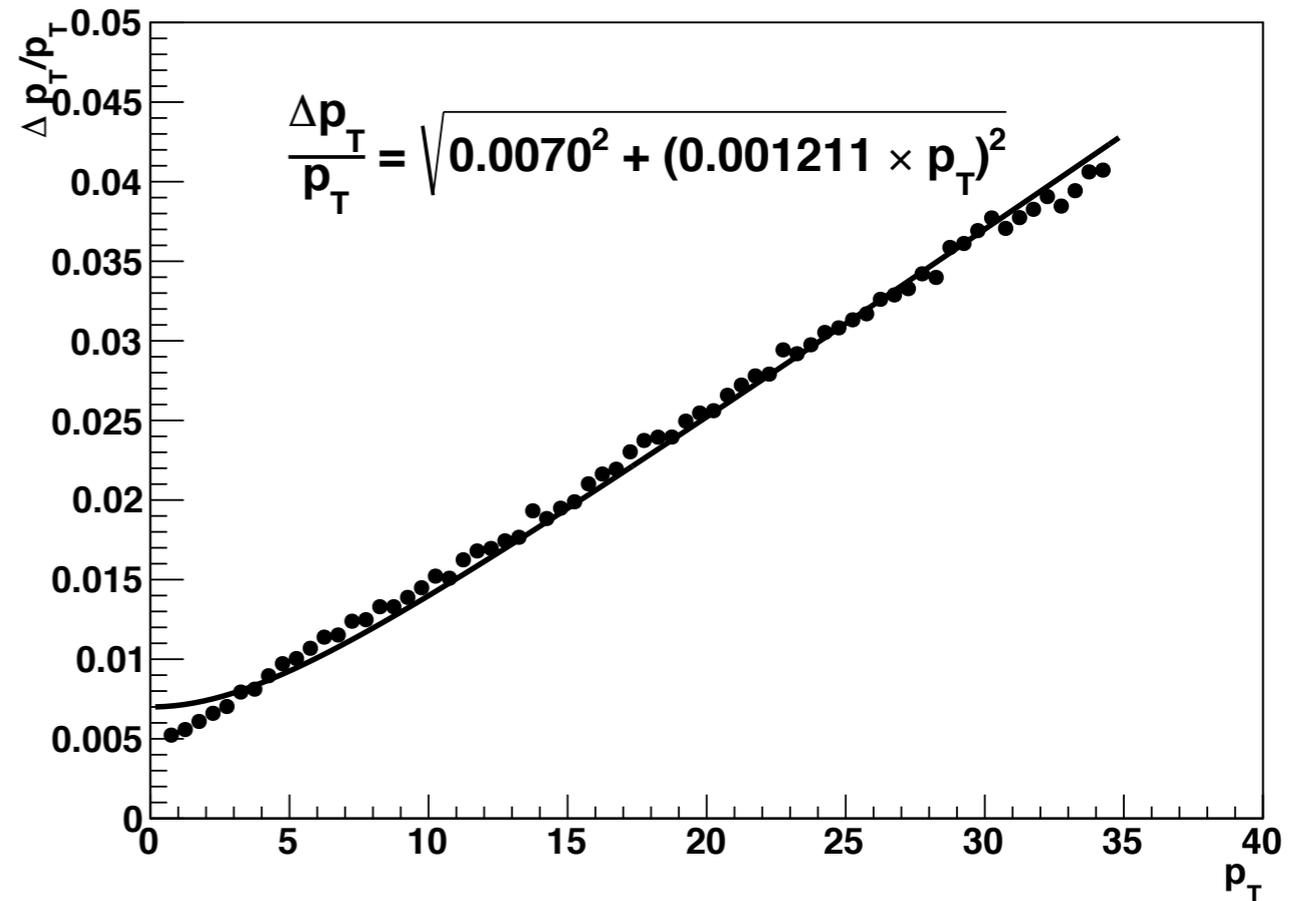
For Upsilon and pions we require:

- $\text{quality} < 3$
- $\text{dca2d} < 1 \text{ mm}$
- $\text{dcaZ} < 1 \text{ mm}$

With MVTX barrel

With MVTX - p_T resolution vs TPC layers

100 pions 60 TPC layers

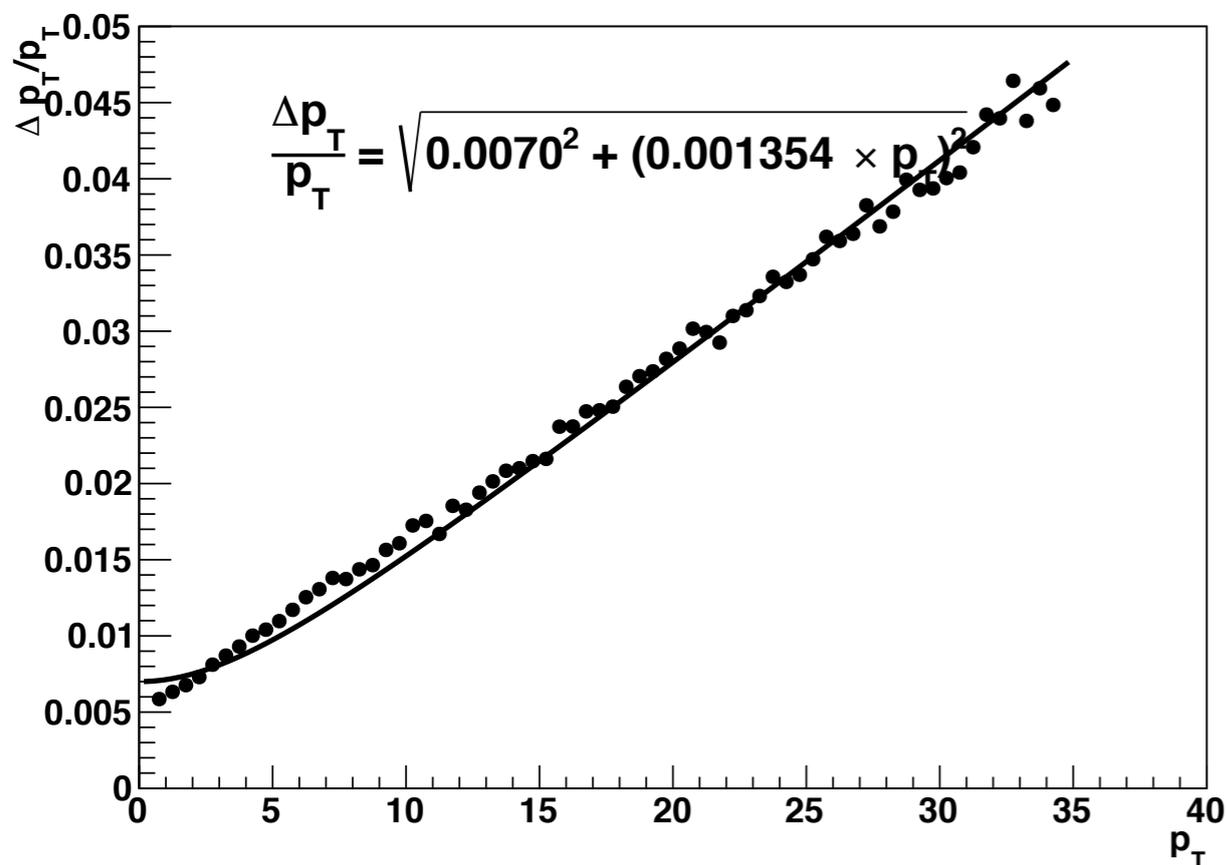
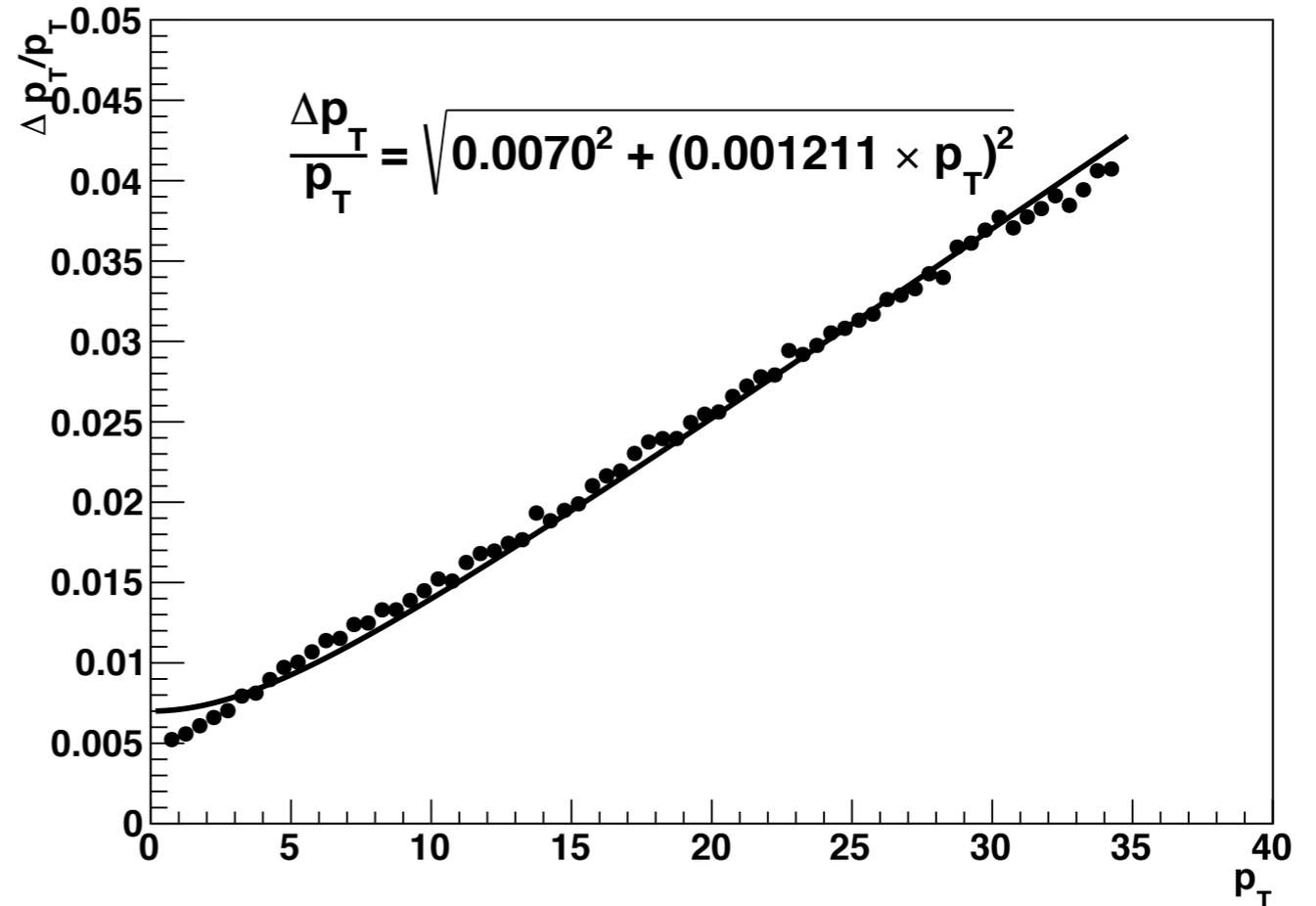


100 pions 40 TPC layers

About 5% worse at higher p_T

With MVTX - p_T resolution vs occupancy

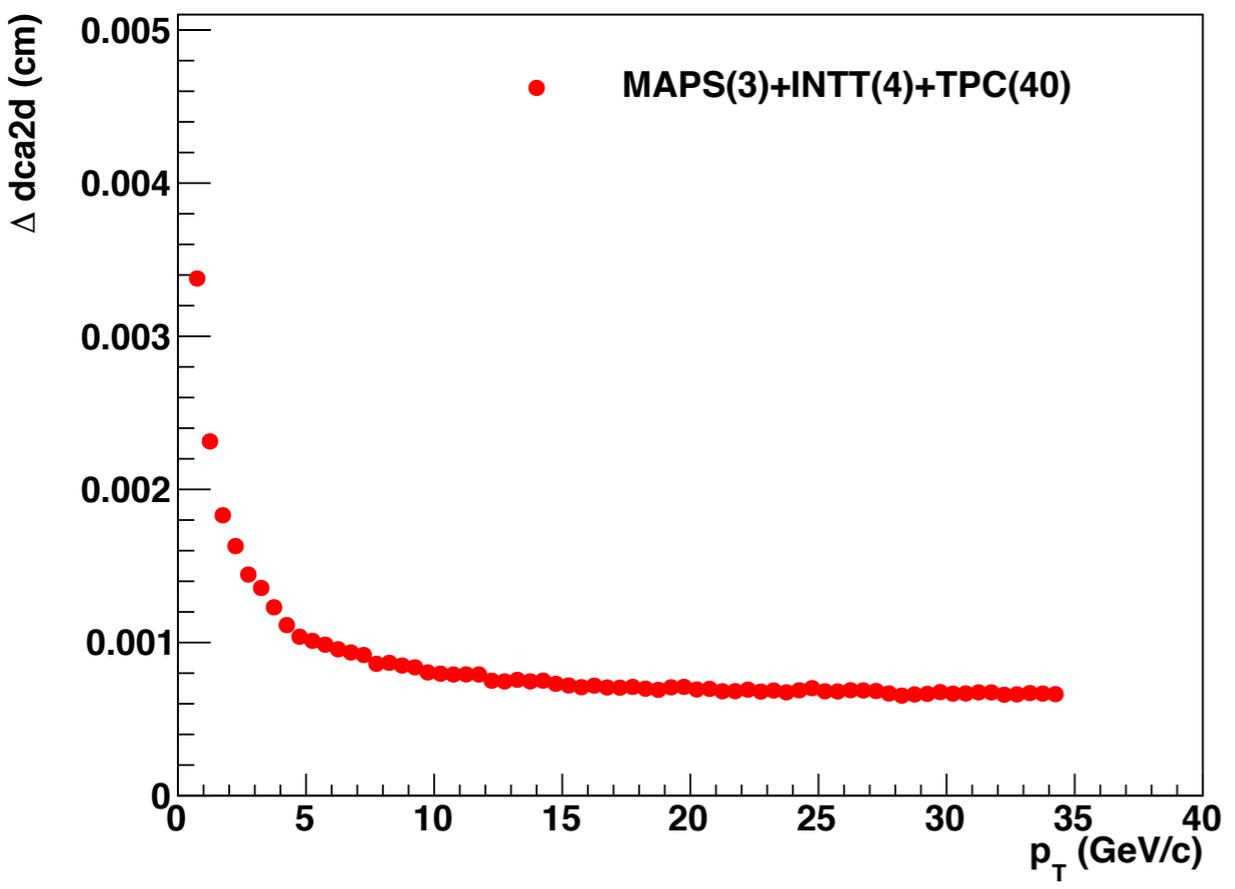
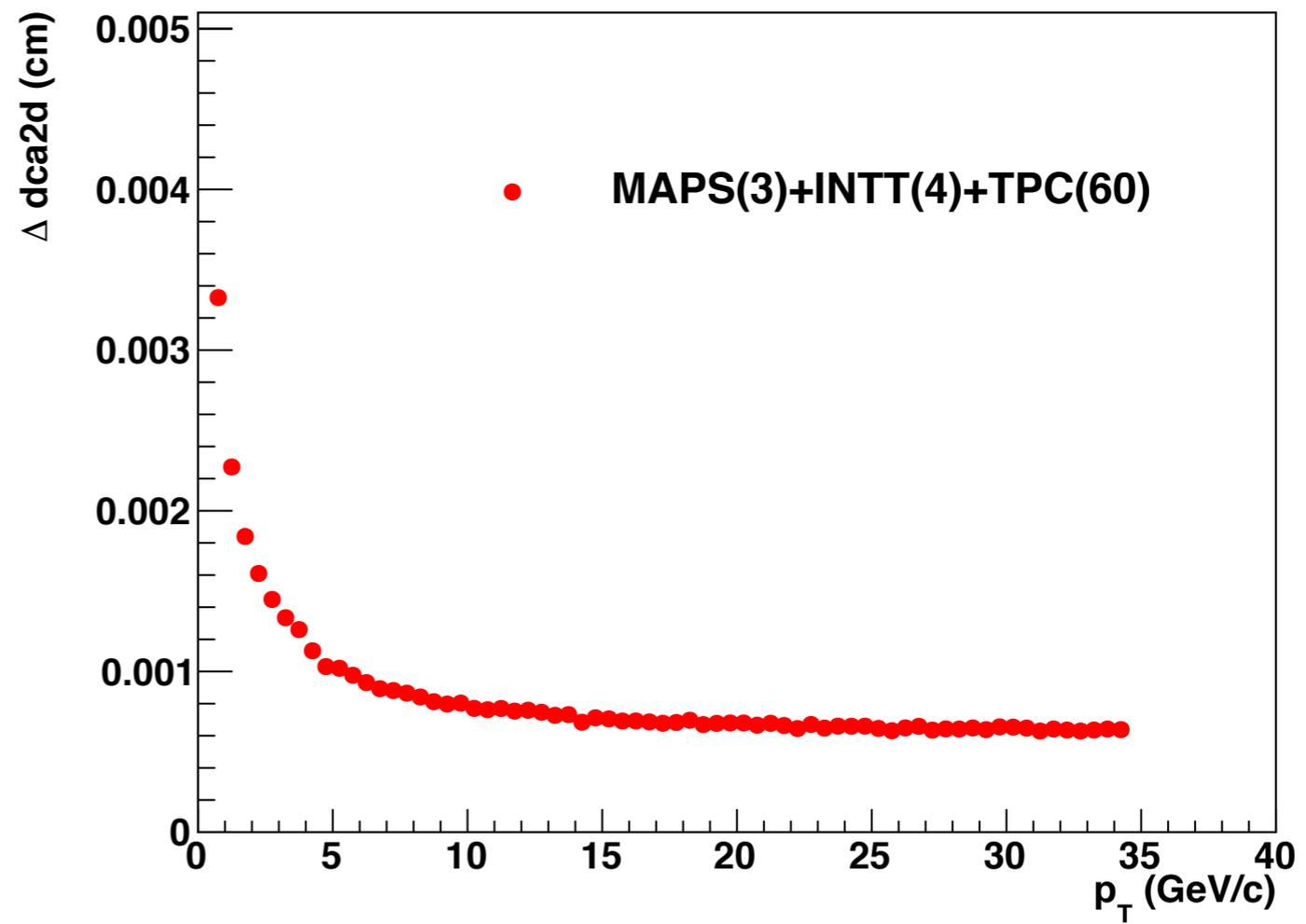
100 pions 60 TPC
layers



100 pions embedded in
central Hijing events
60 TPC layers

With MVTX - dca2d resolution vs TPC layers

100 pions 60 TPC layers

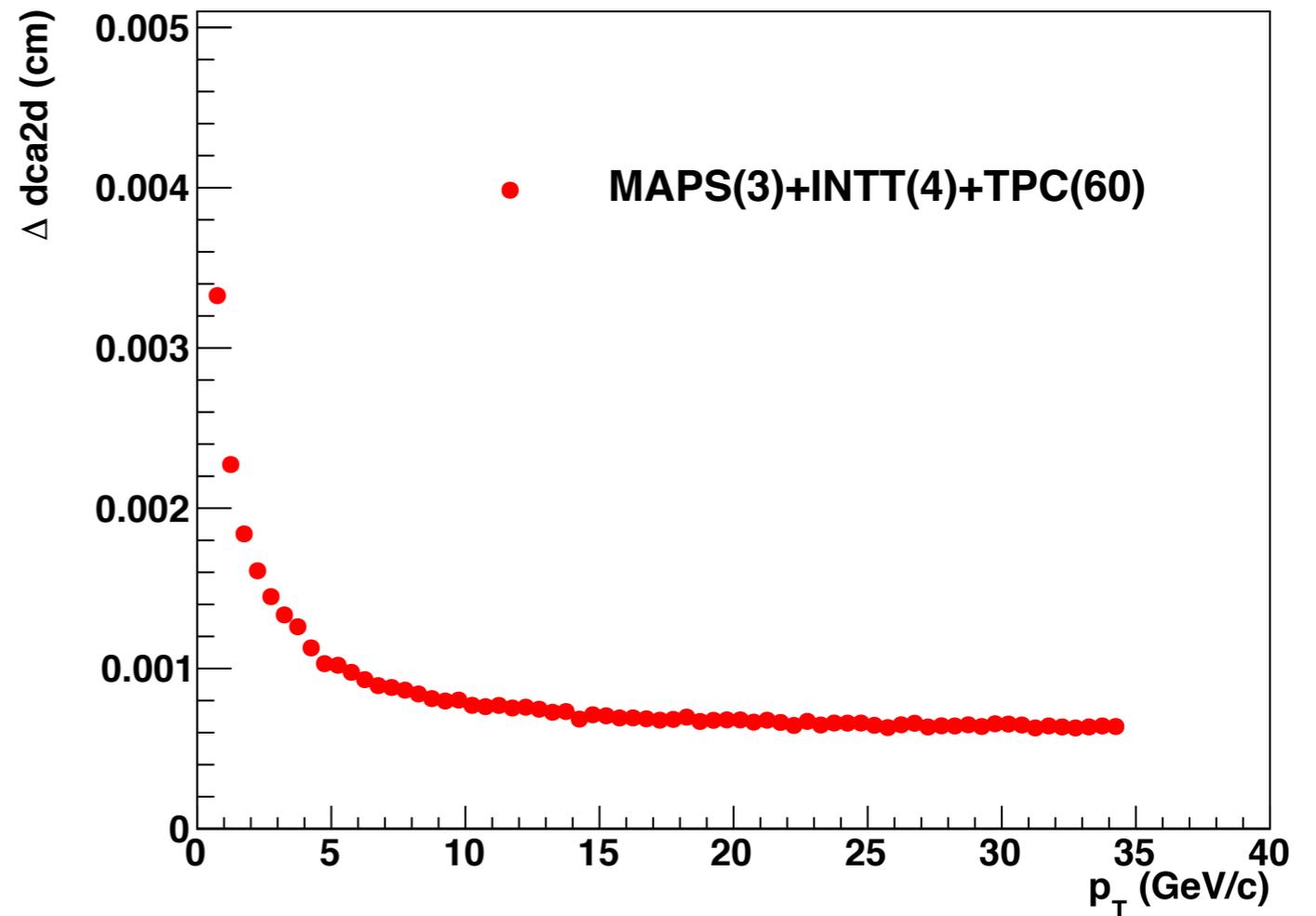
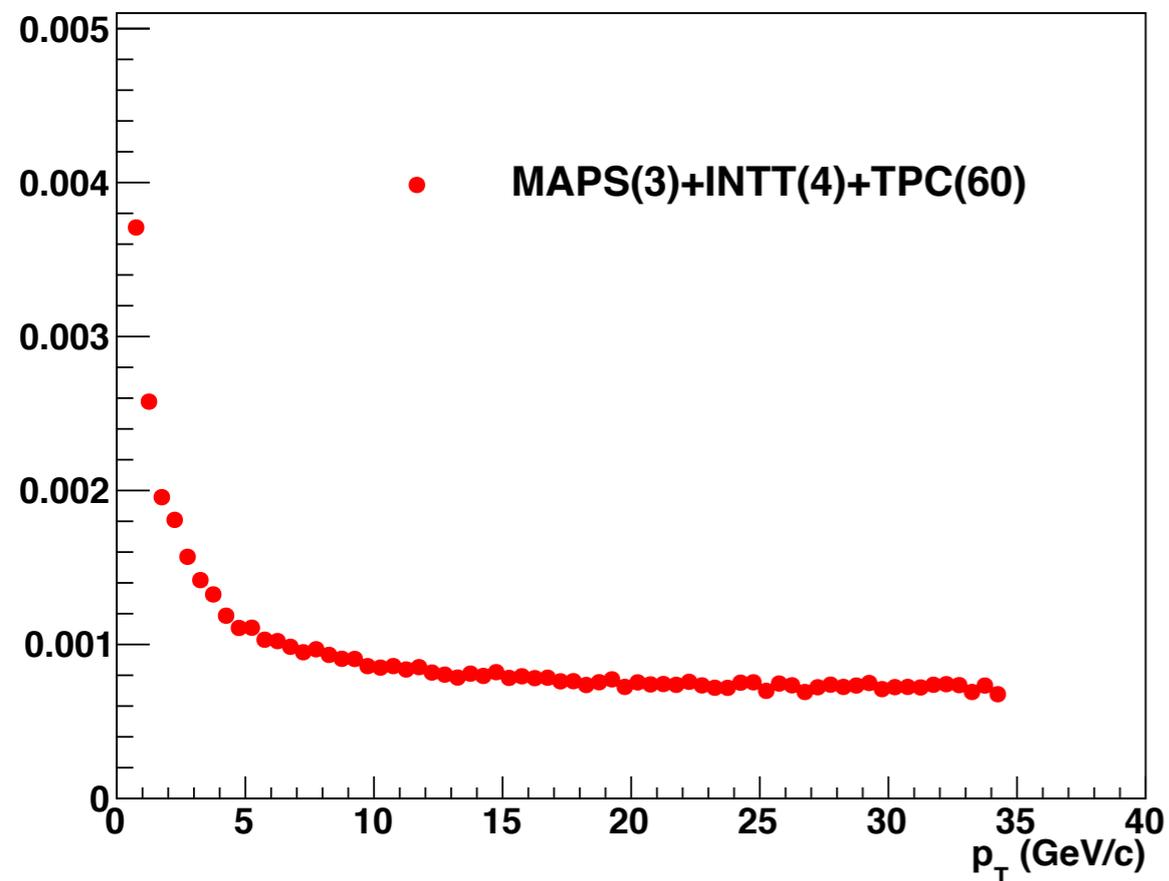


100 pions 40 TPC layers

Essentially no change

With MVTX - dca2d resolution vs occupancy

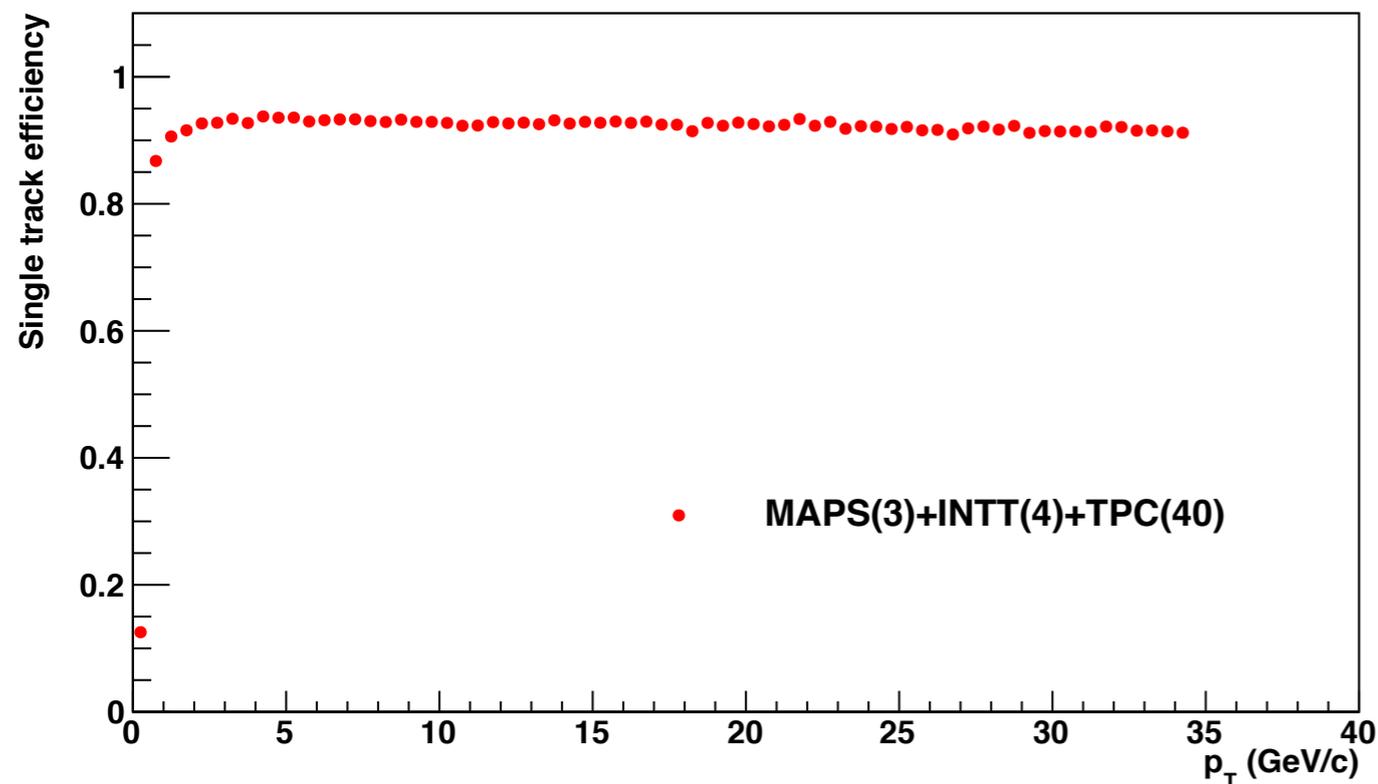
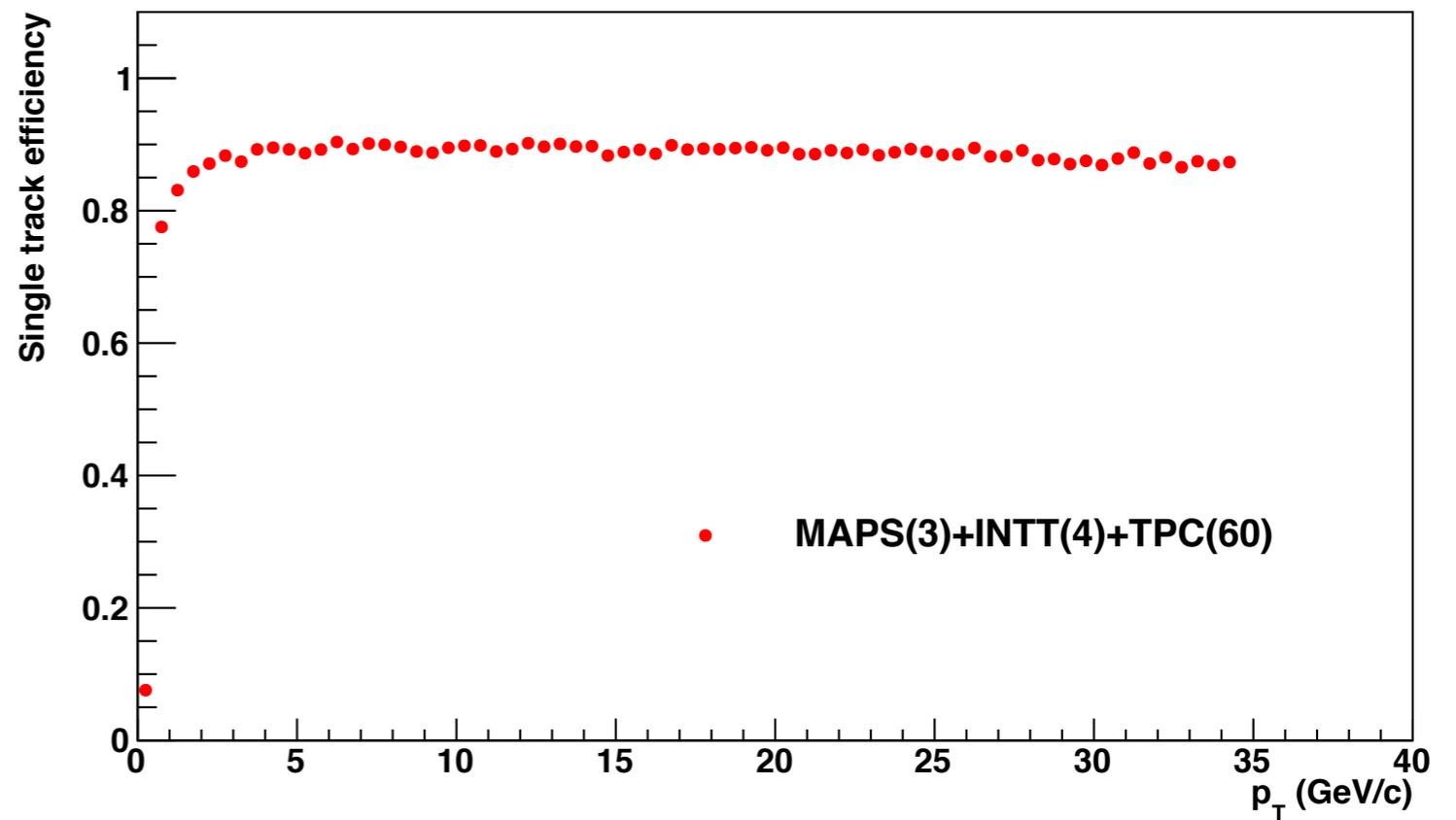
100 pions 60 TPC
layers



100 pions embedded in
central Hijing events 60
TPC layers

With MVTX - Track efficiency vs TPC layers

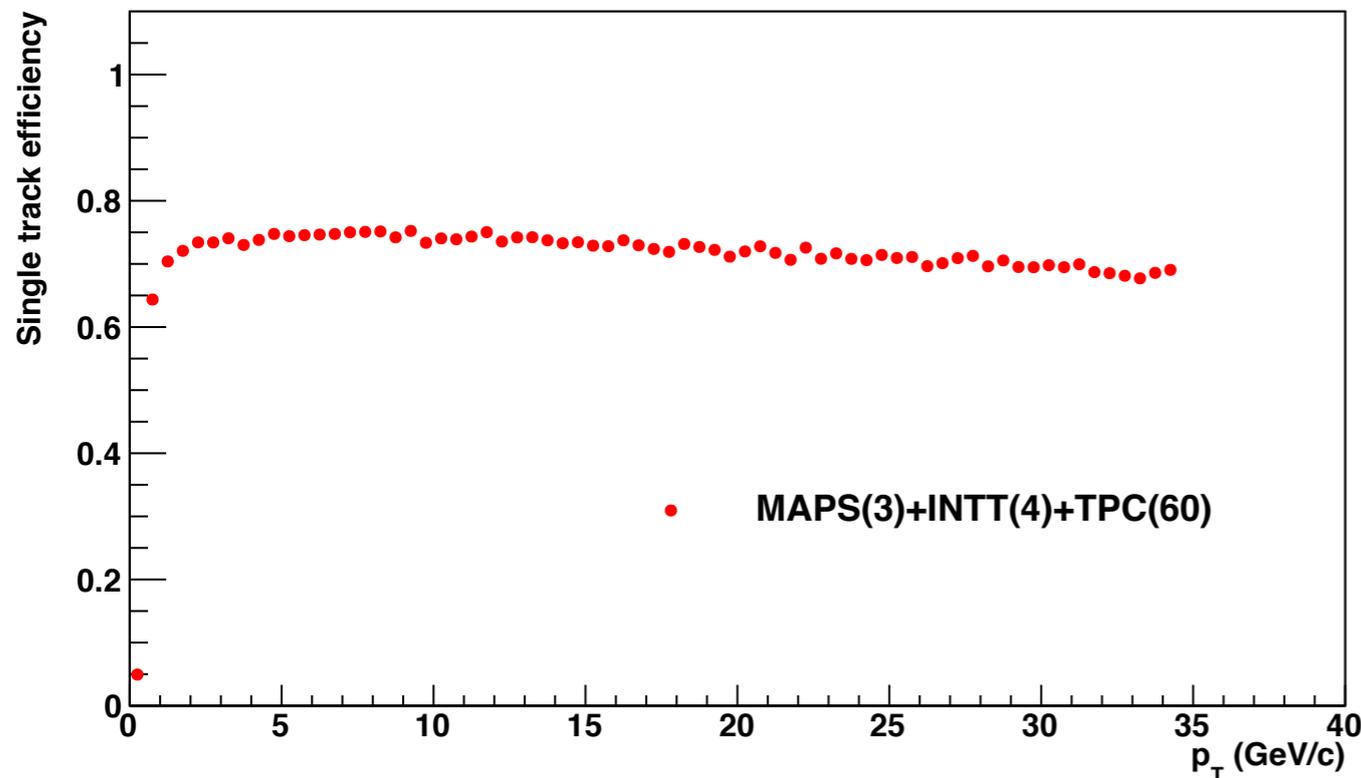
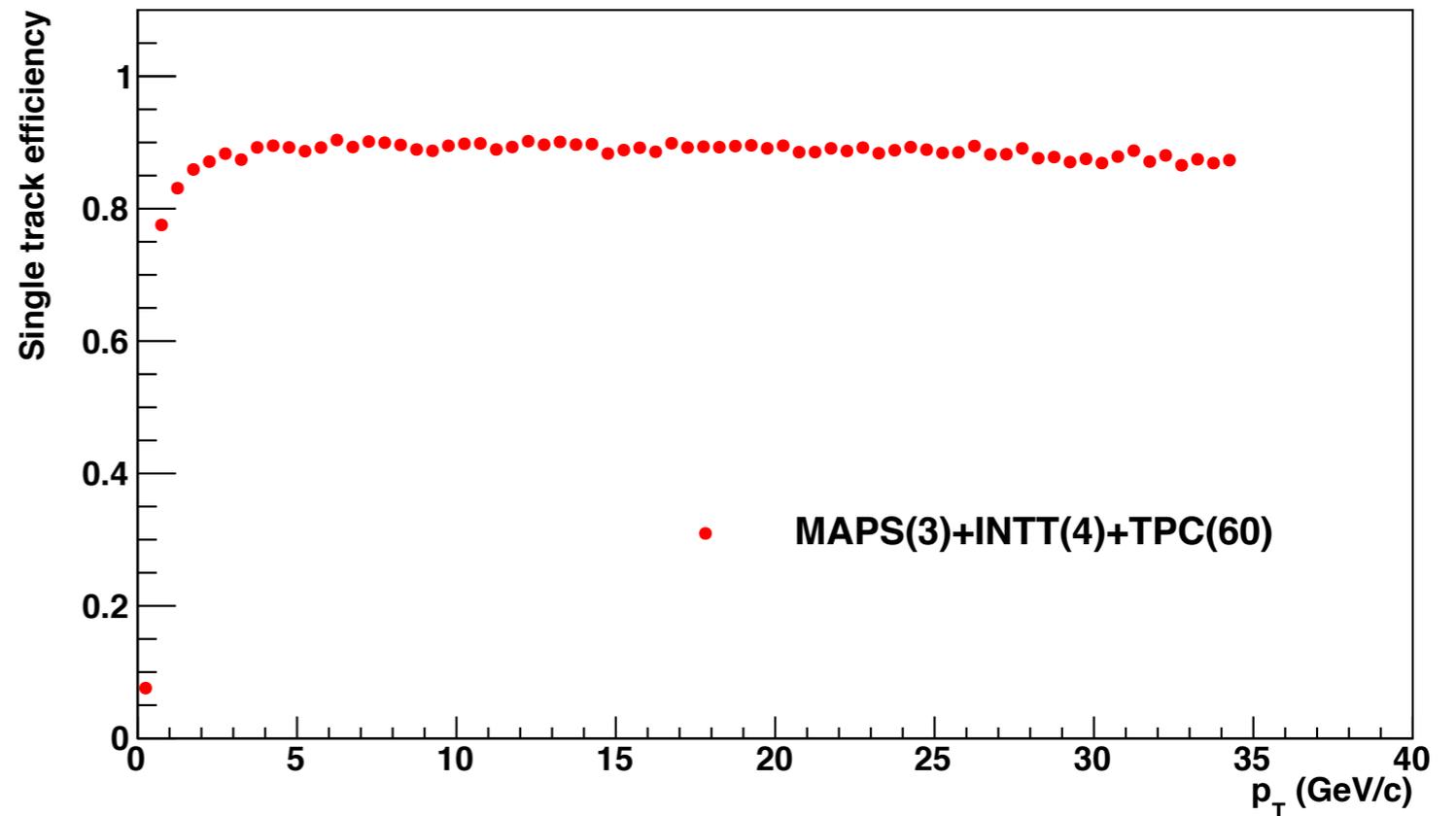
100 pions 60 TPC layers



100 pions 40 TPC layers

With MVTX - Track efficiency vs occupancy

100 pions 60 TPC layers

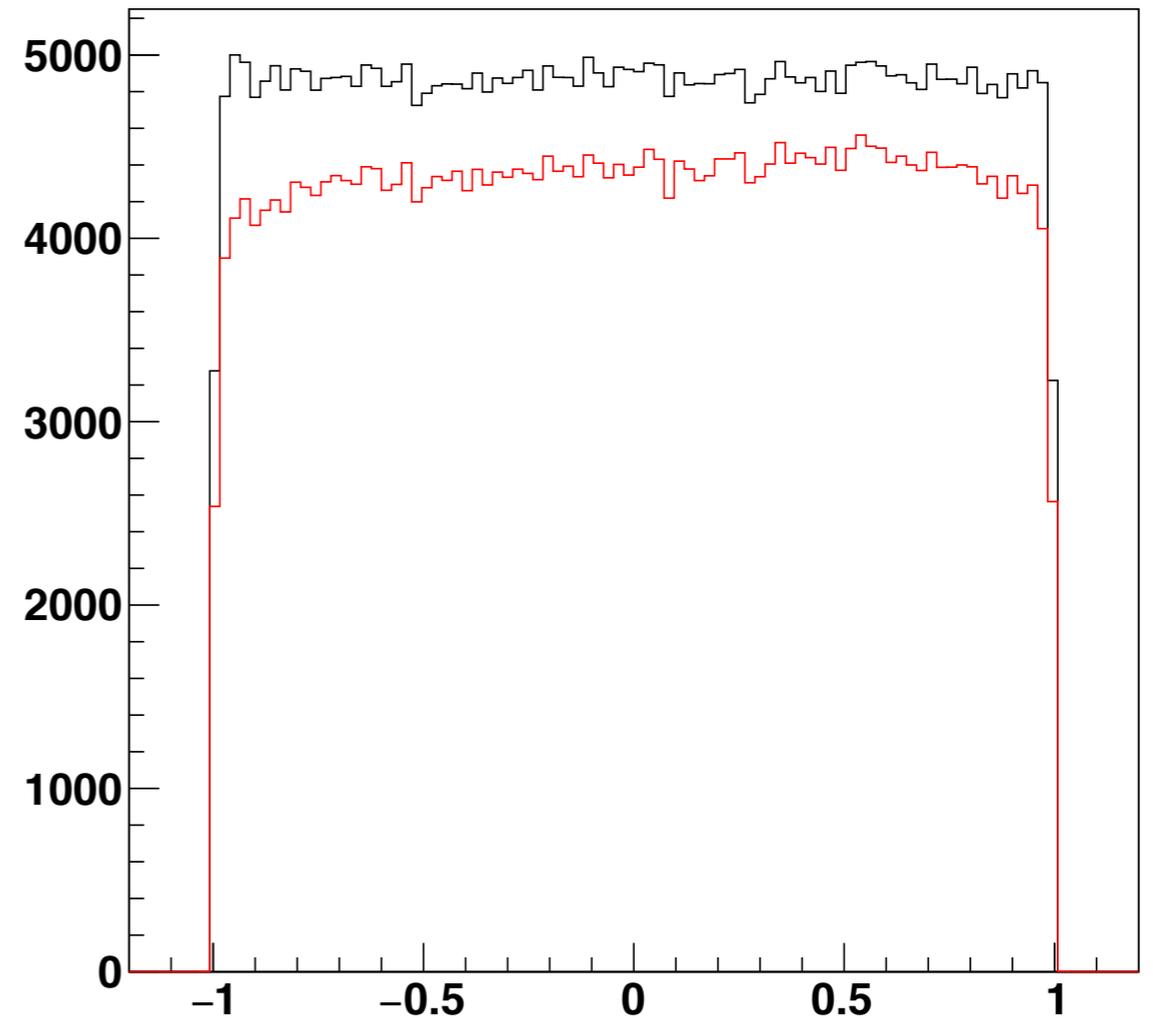
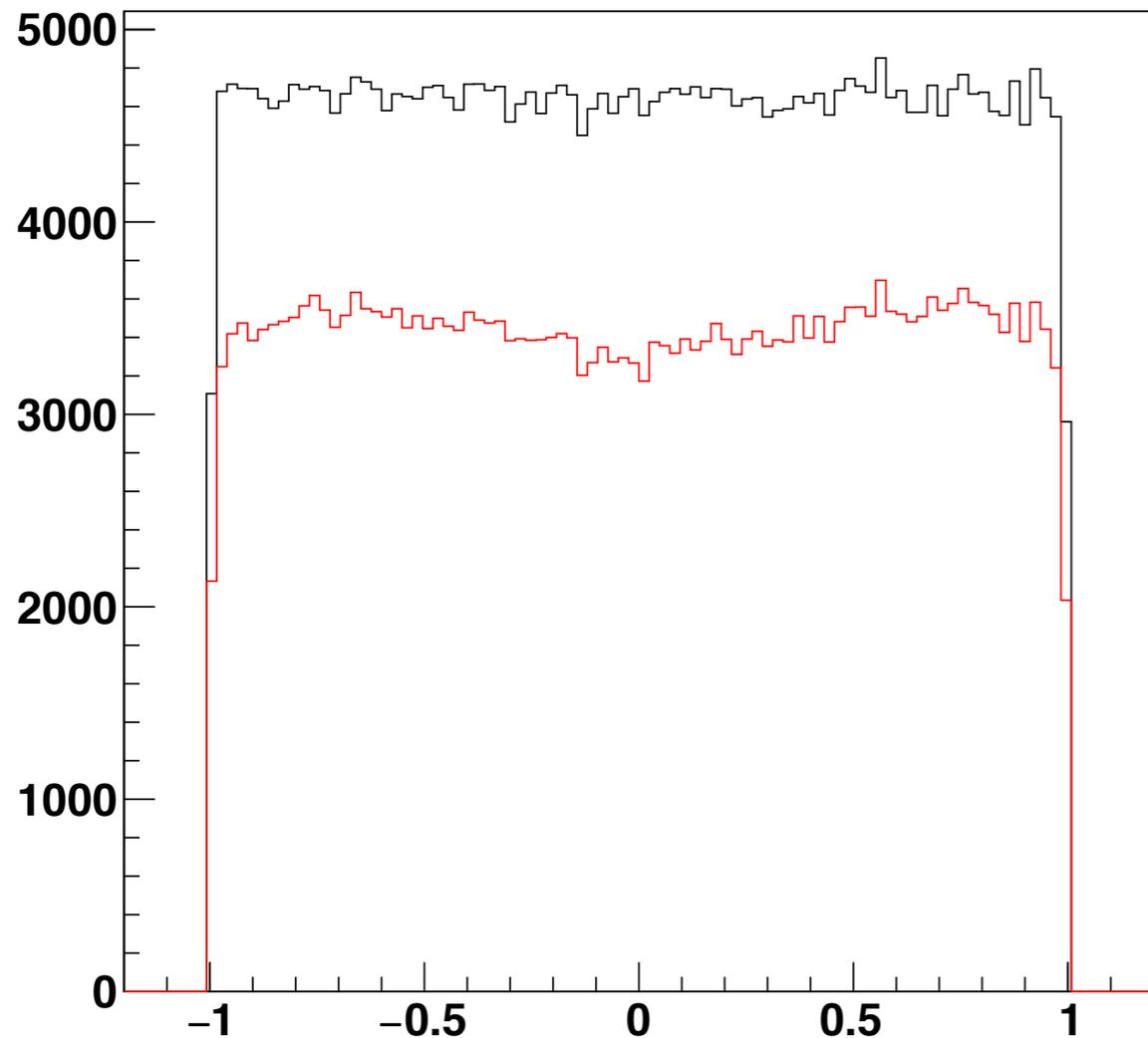


100 pions embedded in central Hijing events 60 TPC layers

Significant reduction in efficiency - but early days yet!

With MVTX - Efficiency with η vs occupancy

100 pions 60 TPC layers



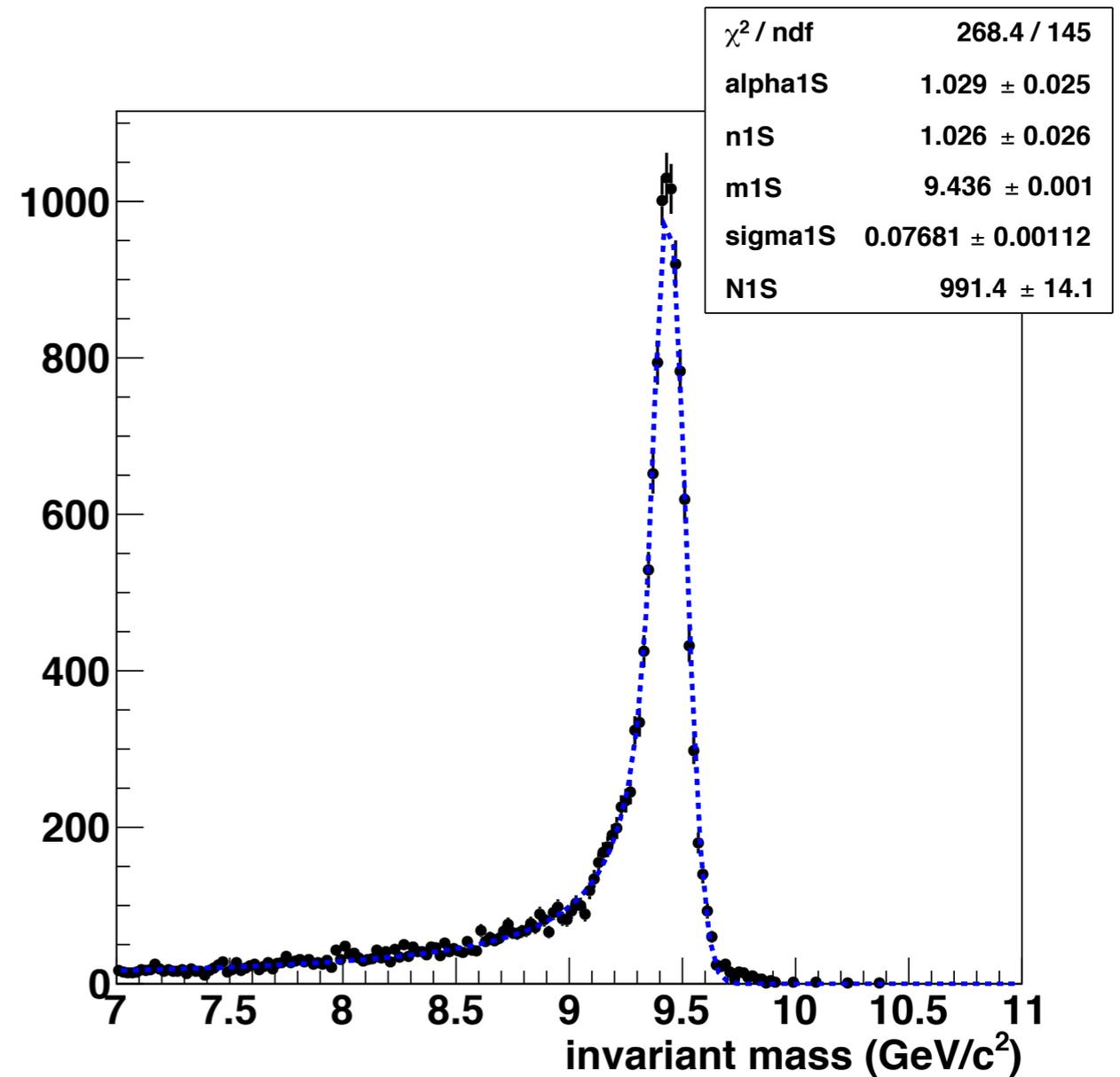
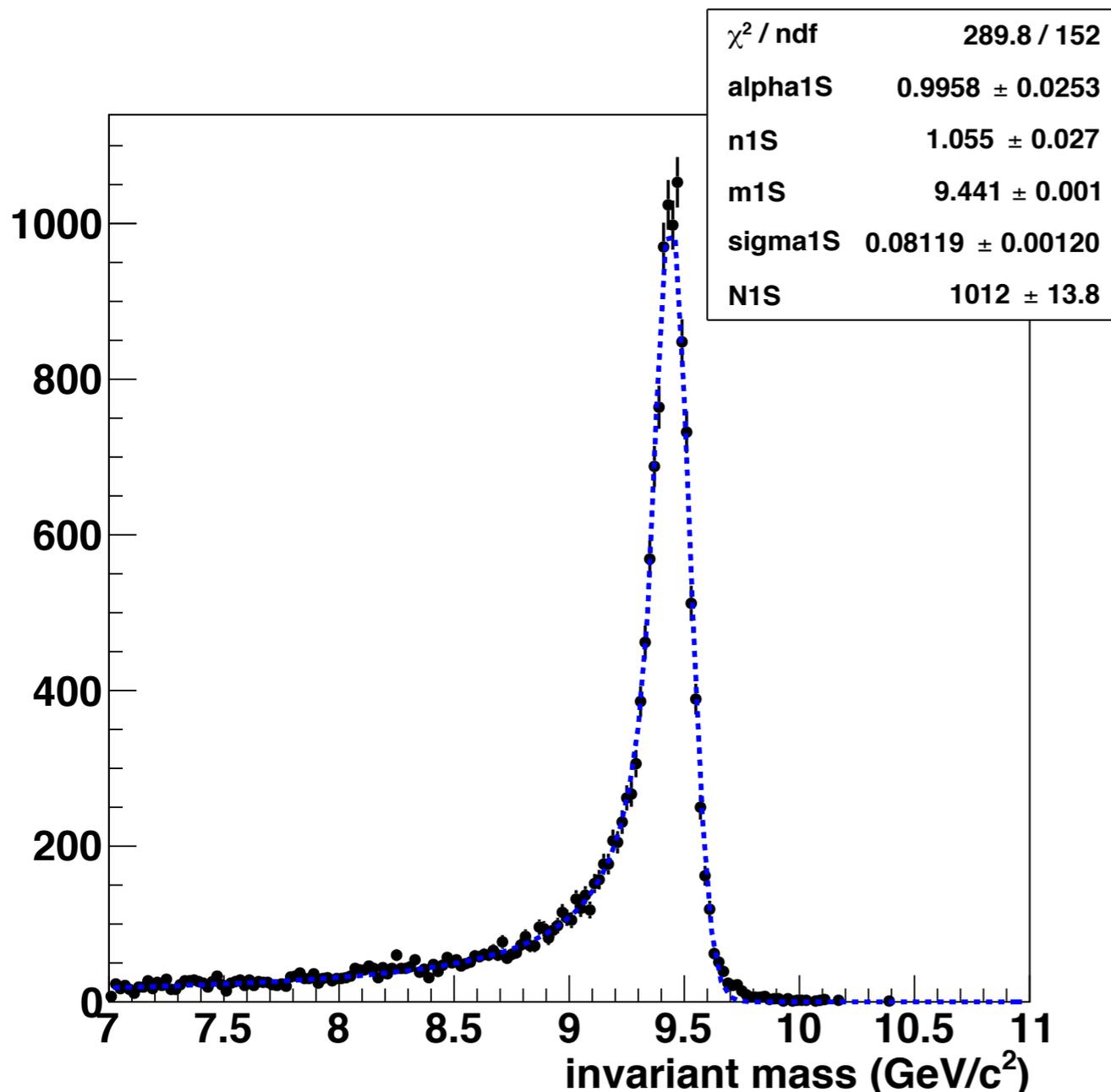
100 pions embedded in central Hijing events 60 TPC layers

With MVTX - Upsilon mass spectrum vs TPC layers

single Upsilon 60 TPC layers

$|Z| < 10, |y| < 1.1$

$\sigma = 76.8 \pm 1.1 \text{ MeV}$



single Upsilon 40 TPC layers

$Z = 0, y < 1.1$

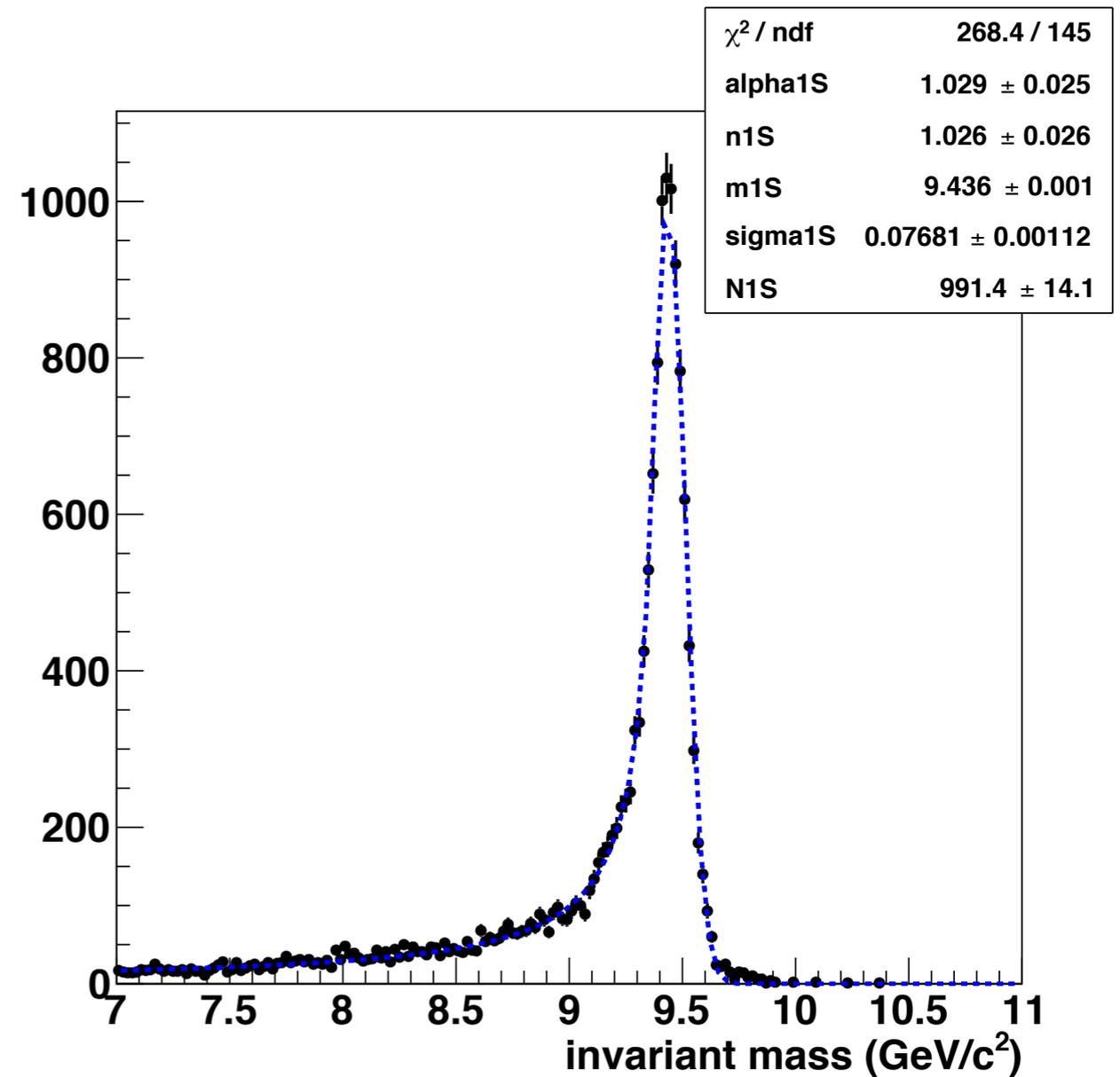
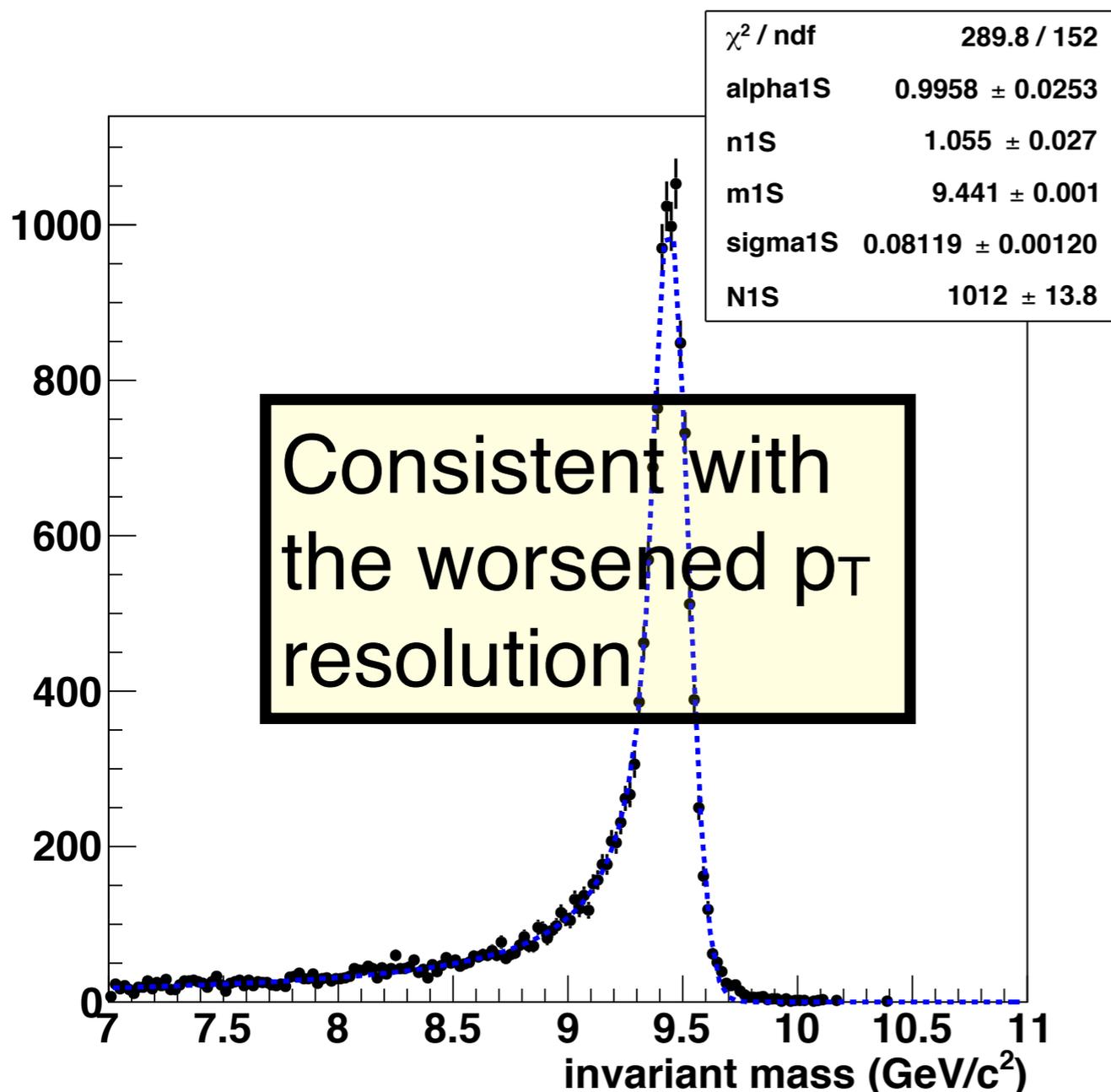
$\sigma = 81.2 \pm 1.2 \text{ MeV}$

With MVTX - Upsilon mass spectrum vs TPC layers

single Upsilon 60 TPC layers

$|Z| < 10, |y| < 1.1$

$\sigma = 76.8 \pm 1.1 \text{ MeV}$



single Upsilon 40 TPC layers

$Z = 0, y < 1.1$

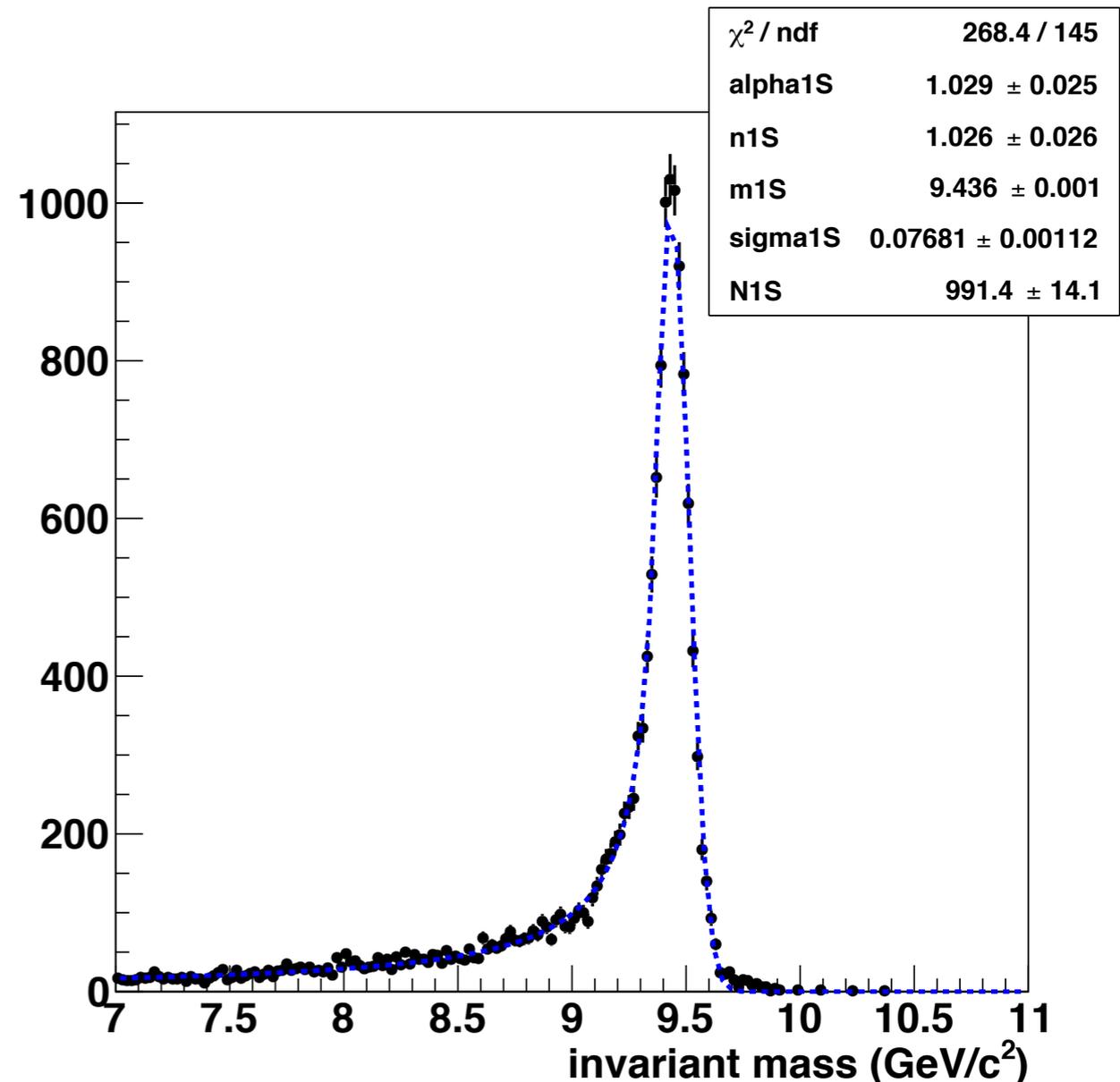
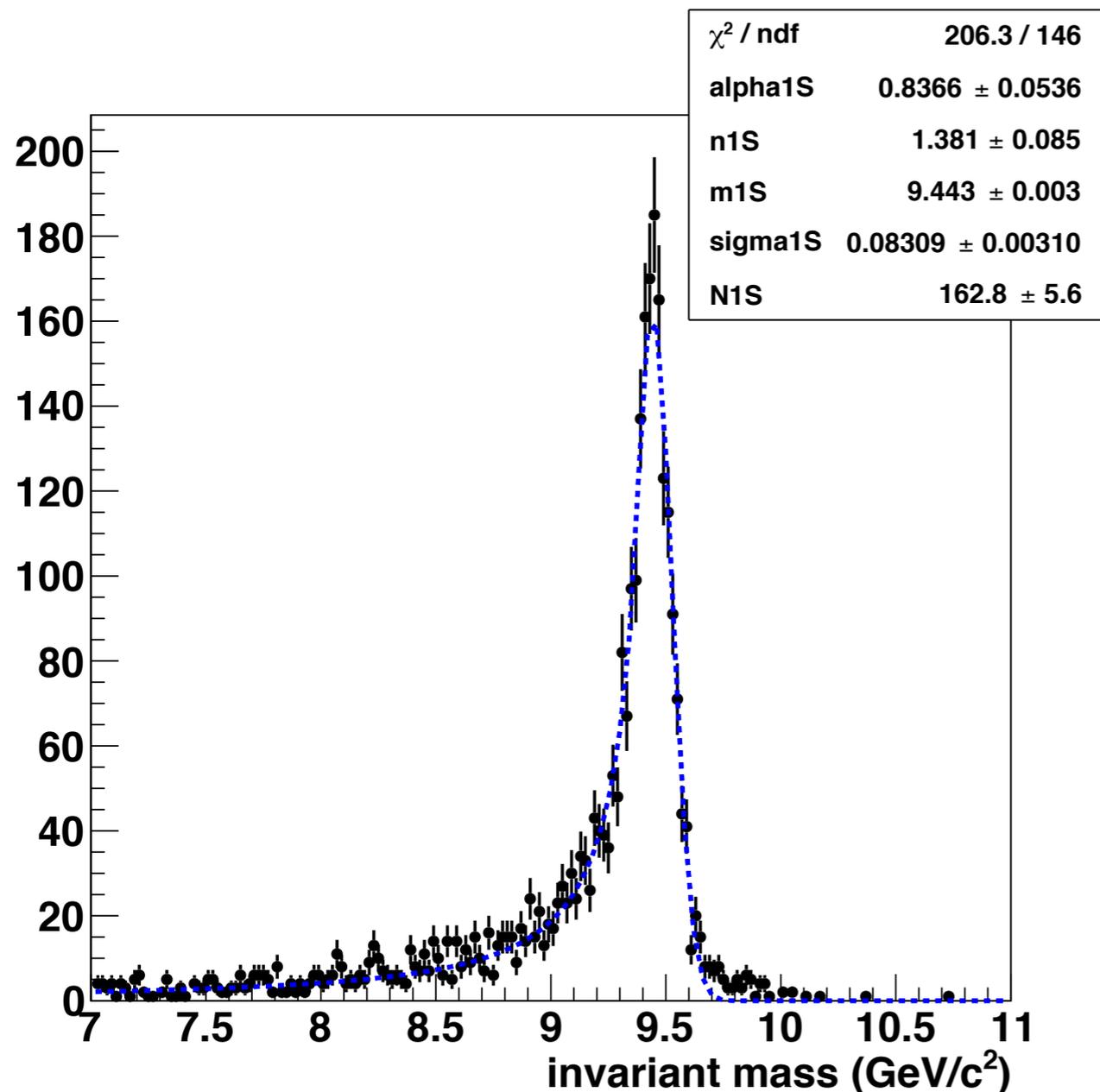
$\sigma = 81.2 \pm 1.2 \text{ MeV}$

With MVTX - Upsilon mass vs occupancy

single Upsilon's 60 TPC layers

$|Z| < 10, |y| < 1.1$

$\sigma = 76.8 \pm 1.1 \text{ MeV}$



Upsilon's embedded in central Hijing events 60 TPC layers

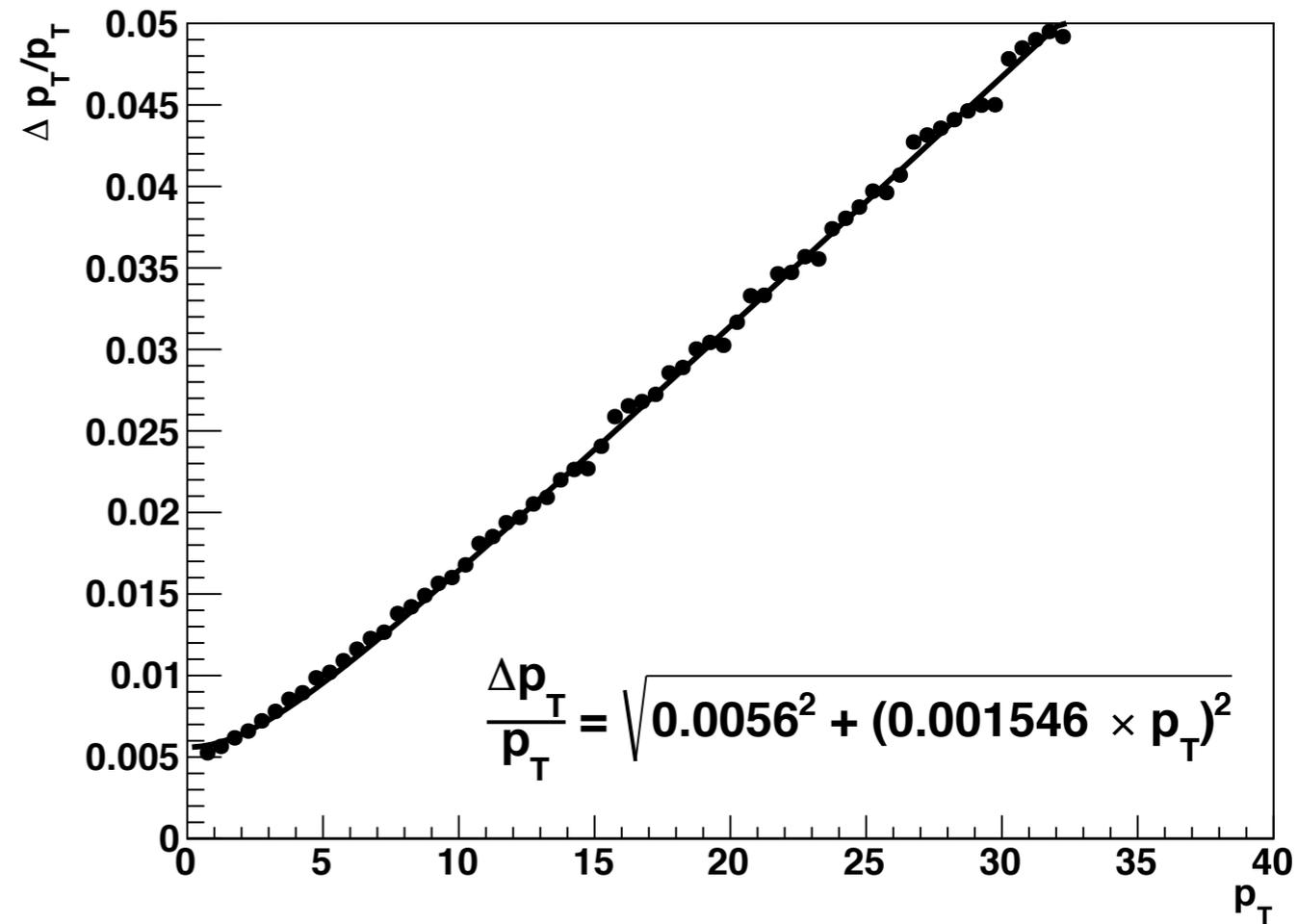
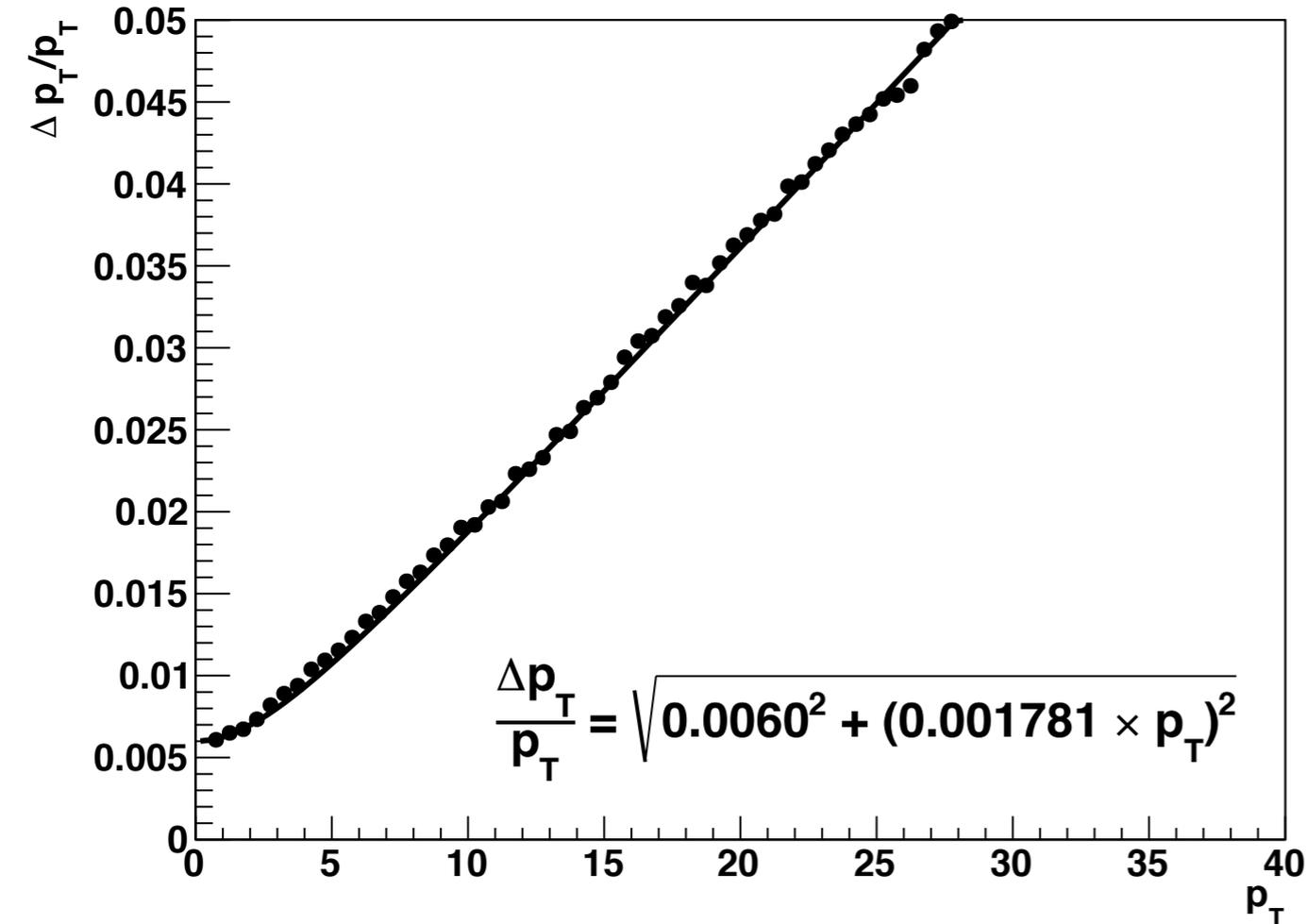
$Z = 0, y < 1.1$

$\sigma = 83 \pm 3 \text{ MeV}$

Without MVTX barrel

Without MVTX - p_T resolution vs occupancy

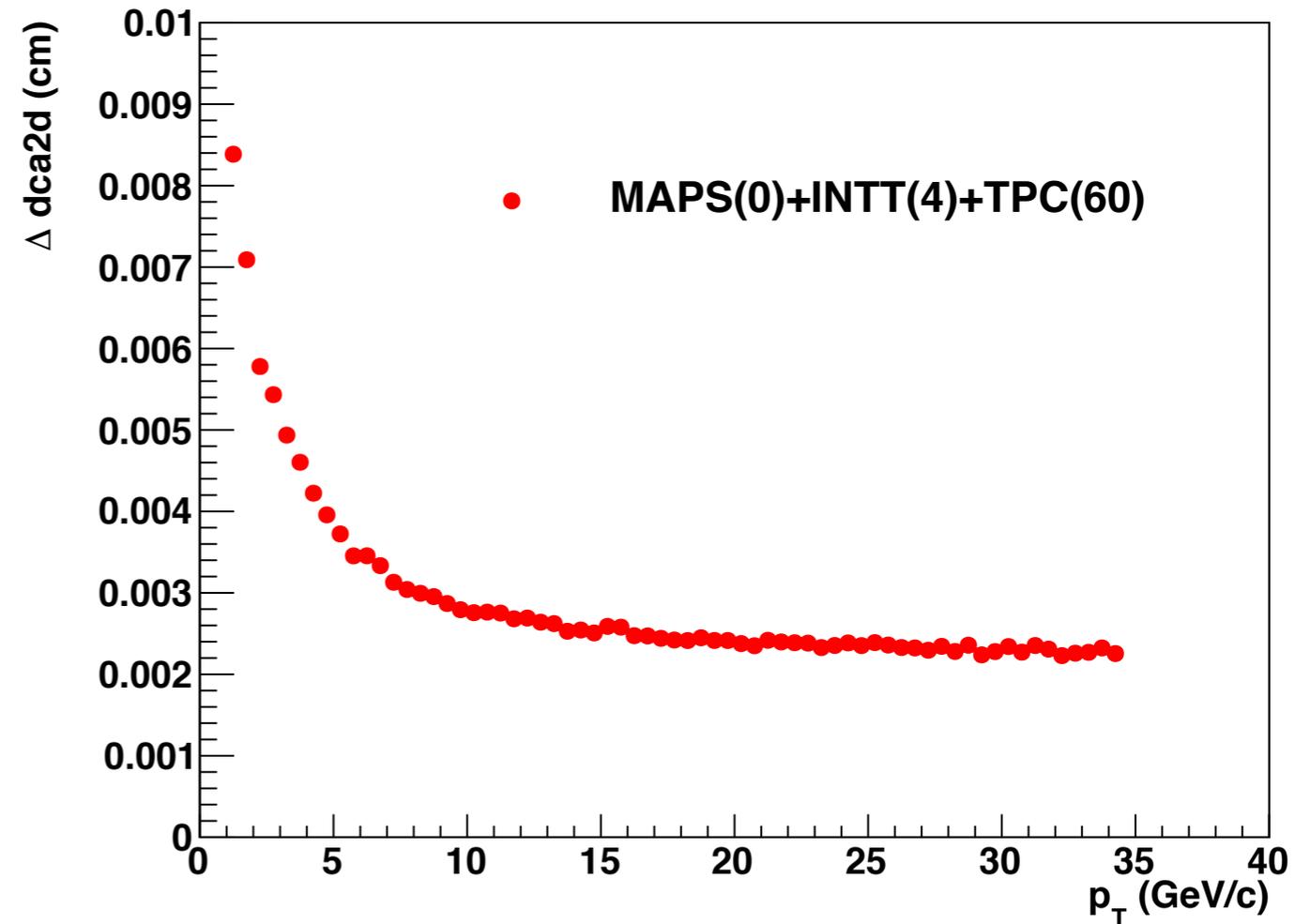
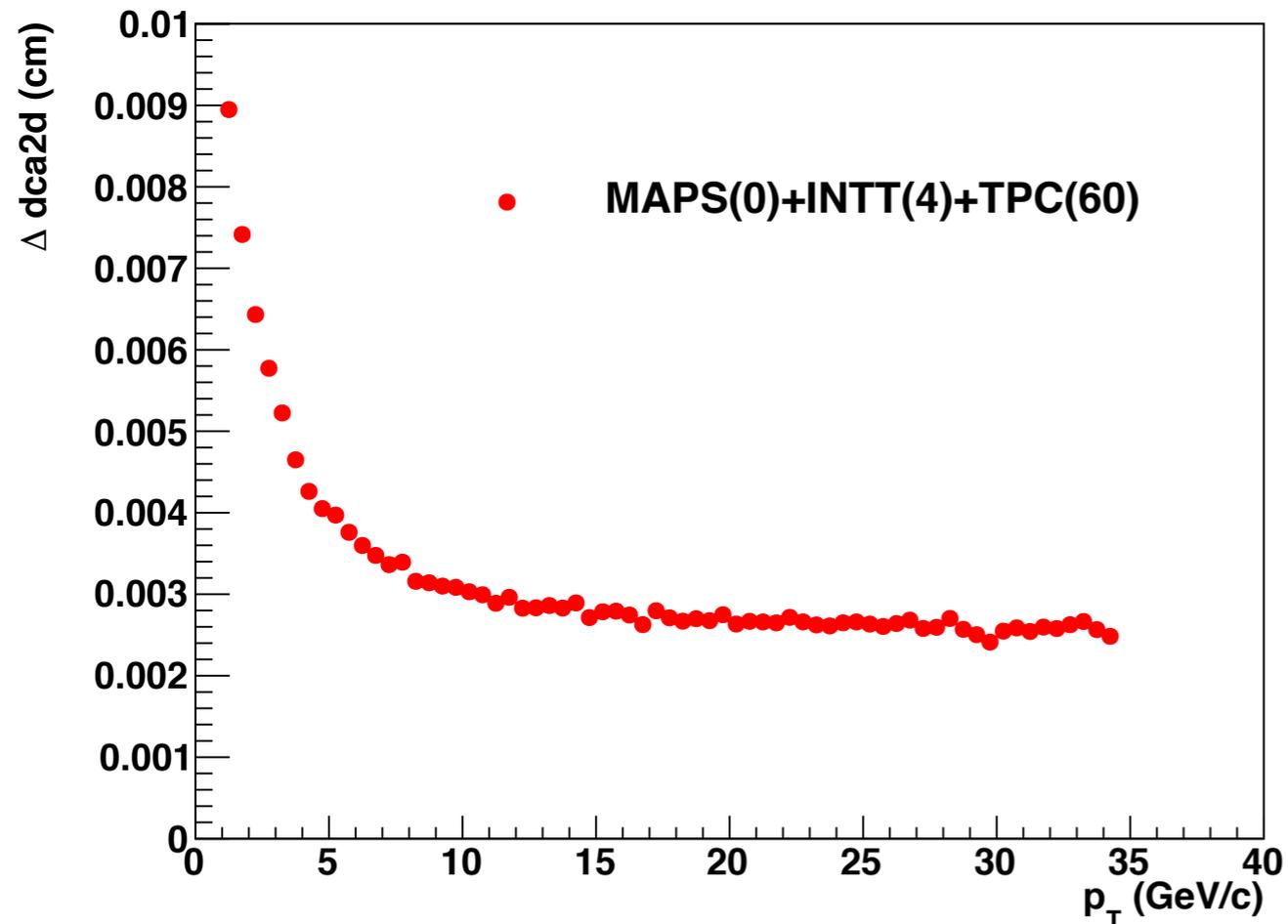
100 pions 60 layer
TPC



100 pions embedded in
central Hijing events 60
layer TPC

Without MVTX - dca2d resolution vs occupancy

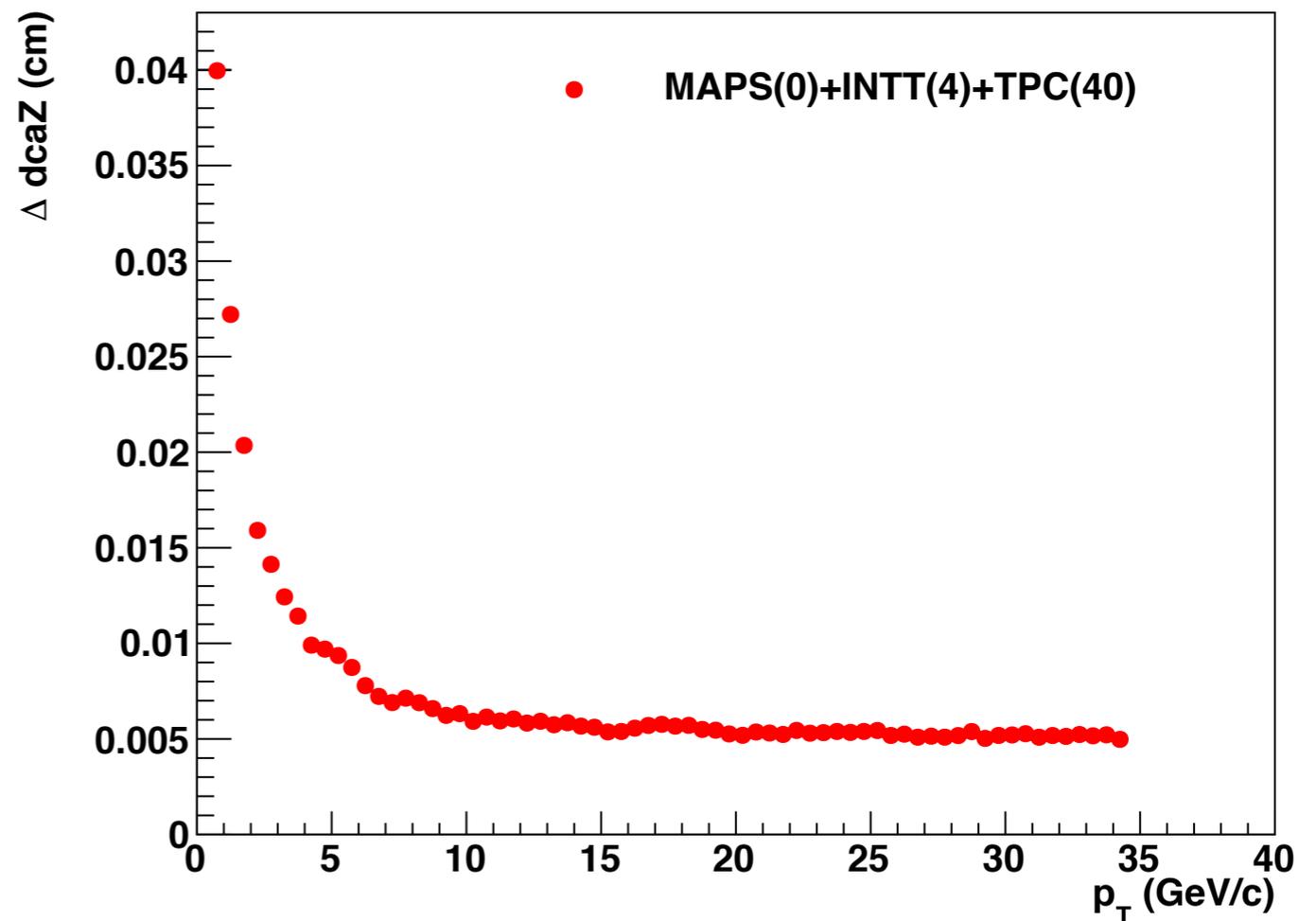
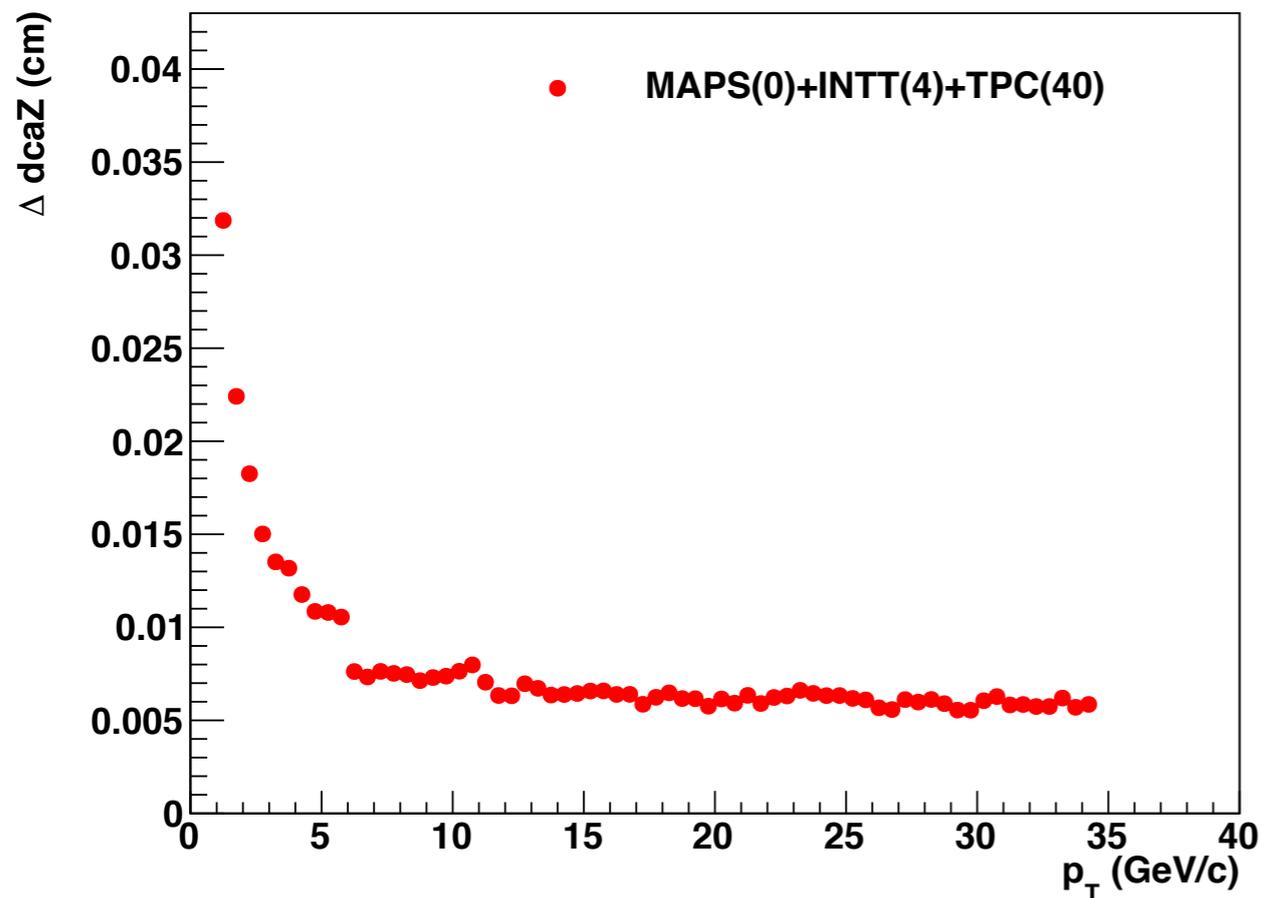
100 pions 60 layer
TPC



100 pions embedded in
central Hijing events 60
layer TPC

Without MVTX - dcaZ resolution

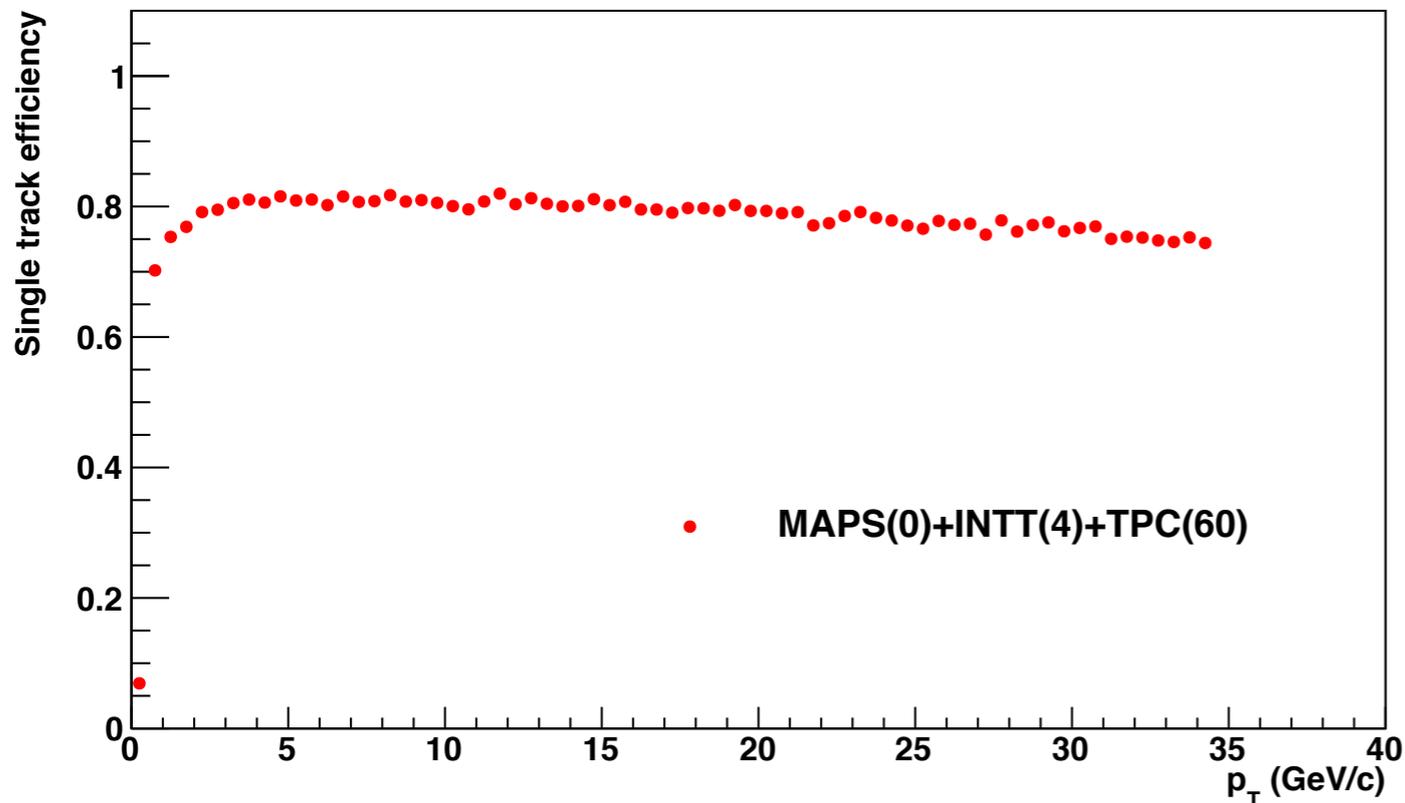
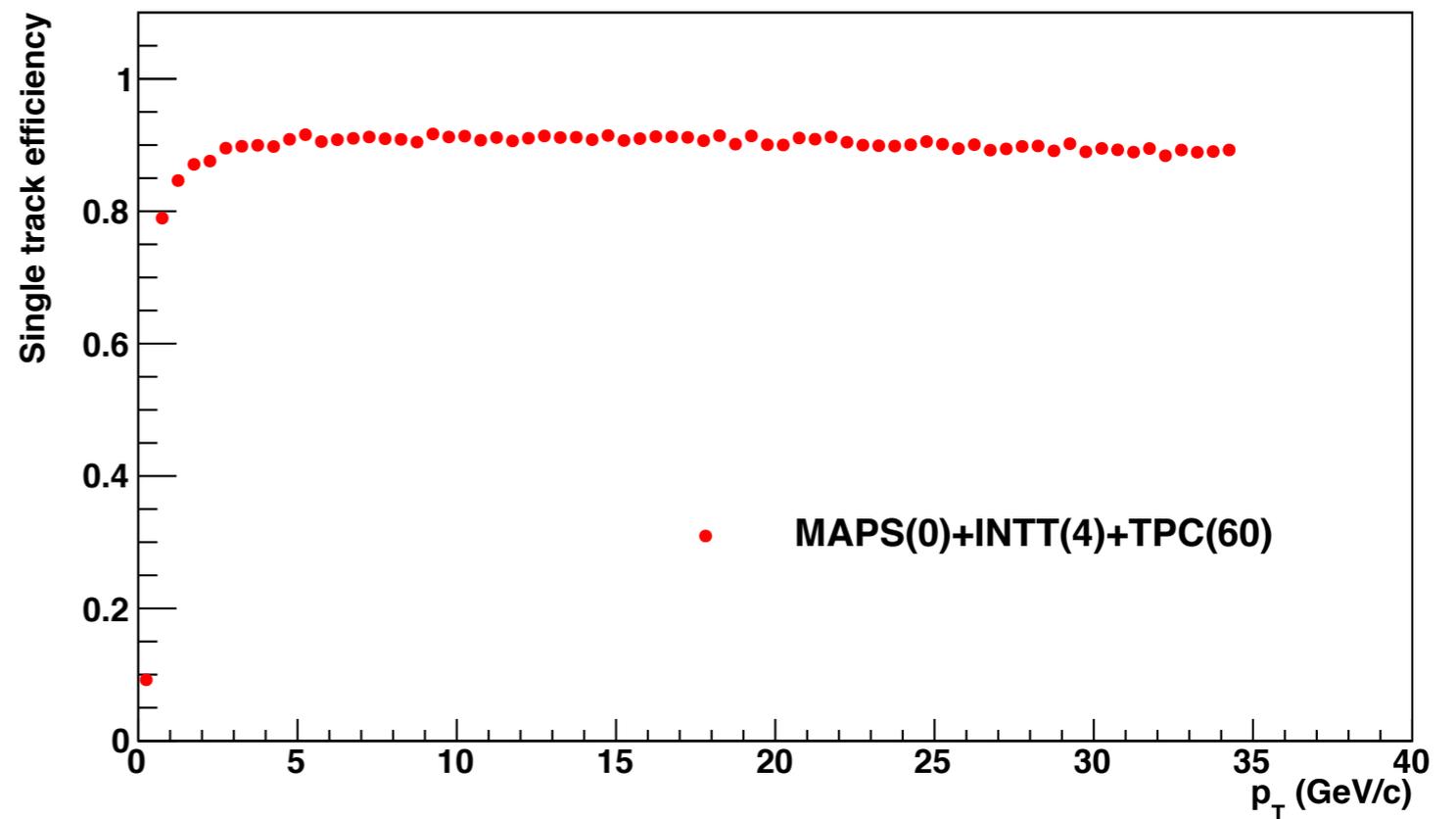
100 pions 60 TPC layers



100 pions embedded in central Hijing events 60 TPC layers

Without MVTX - efficiency vs occupancy

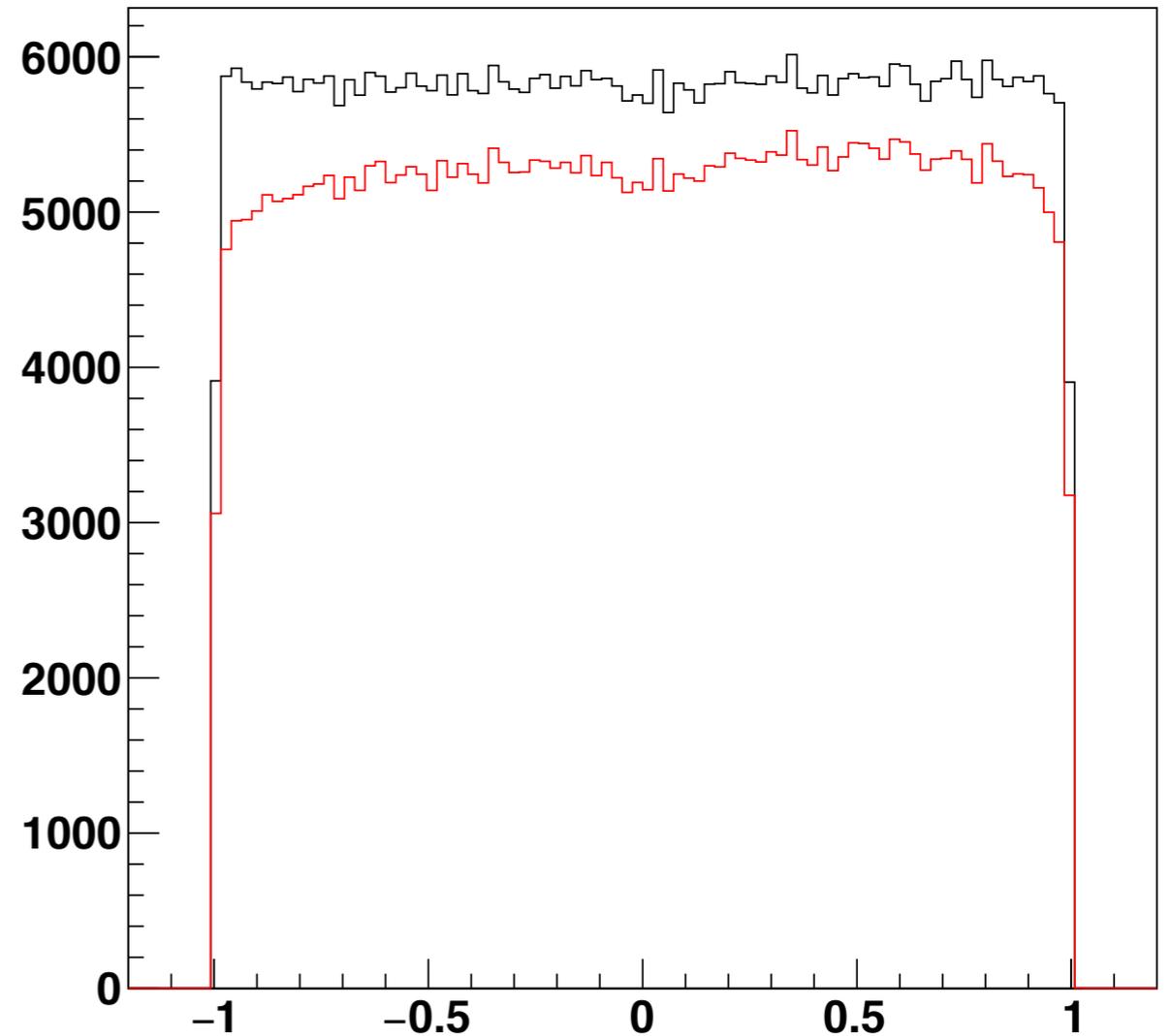
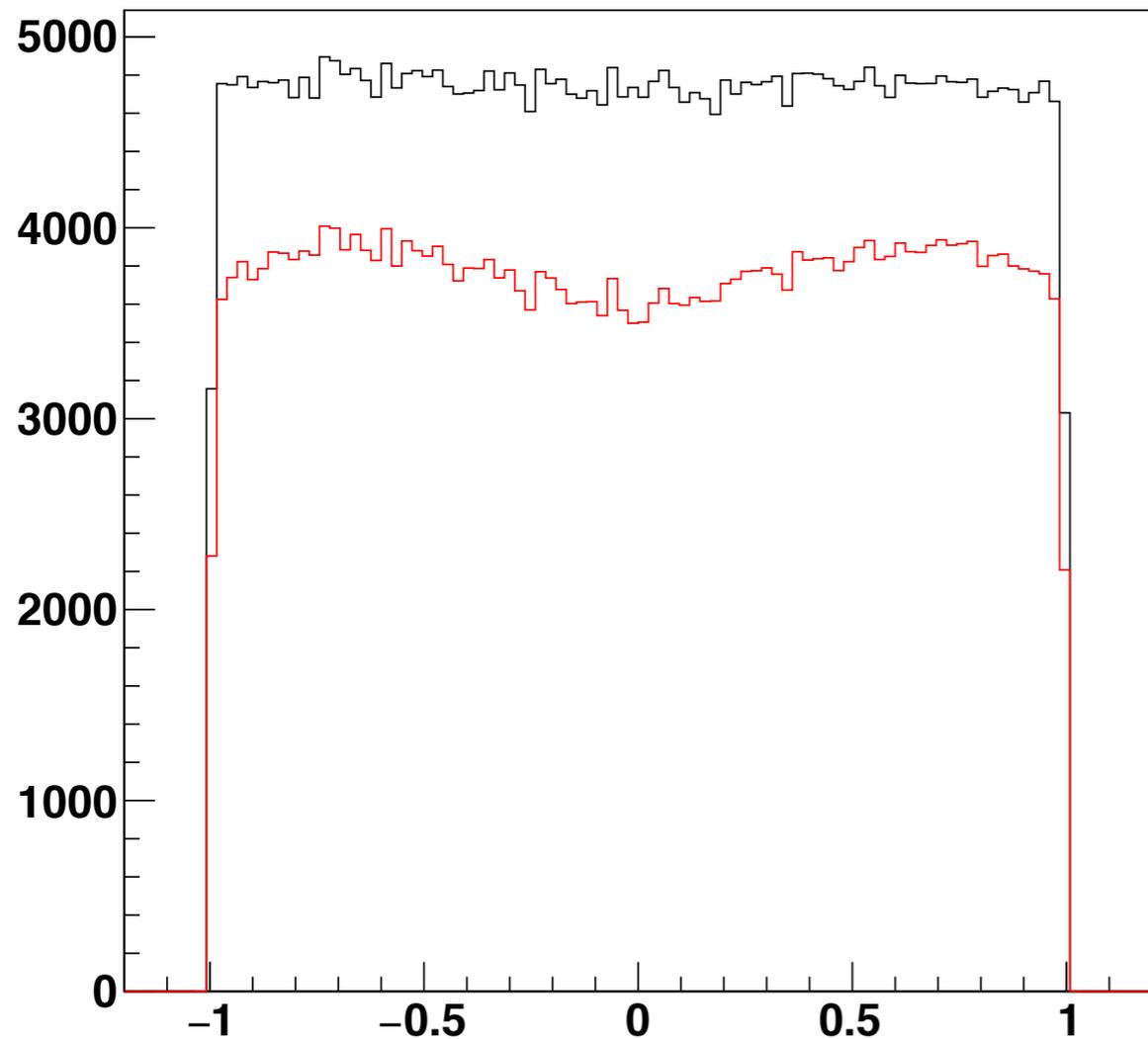
100 pions 60 layer
TPC



100 pions embedded in
central Hijing events 60
layer TPC

Without MVTX - efficiency with η vs occupancy

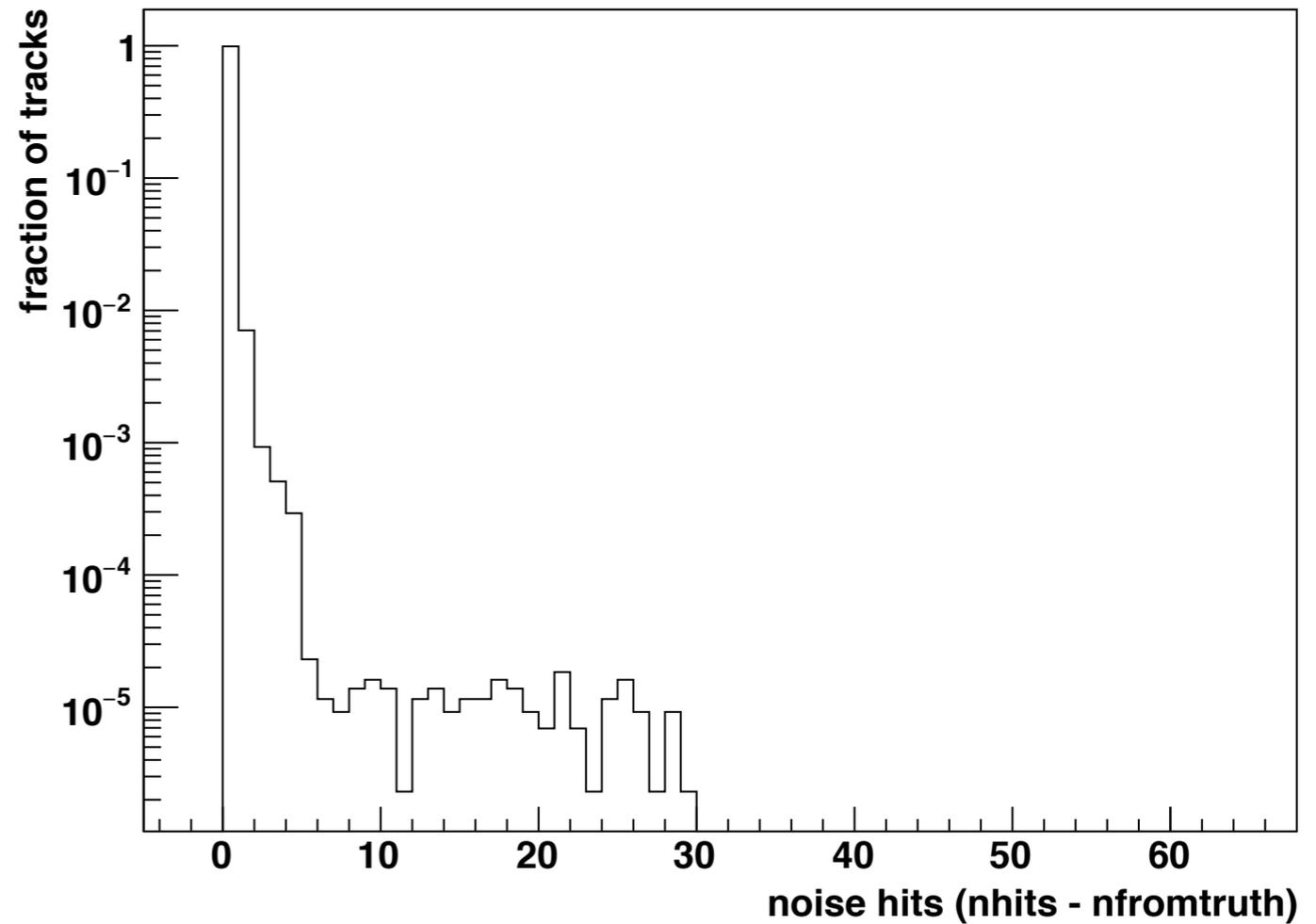
100 pions 60 TPC layers



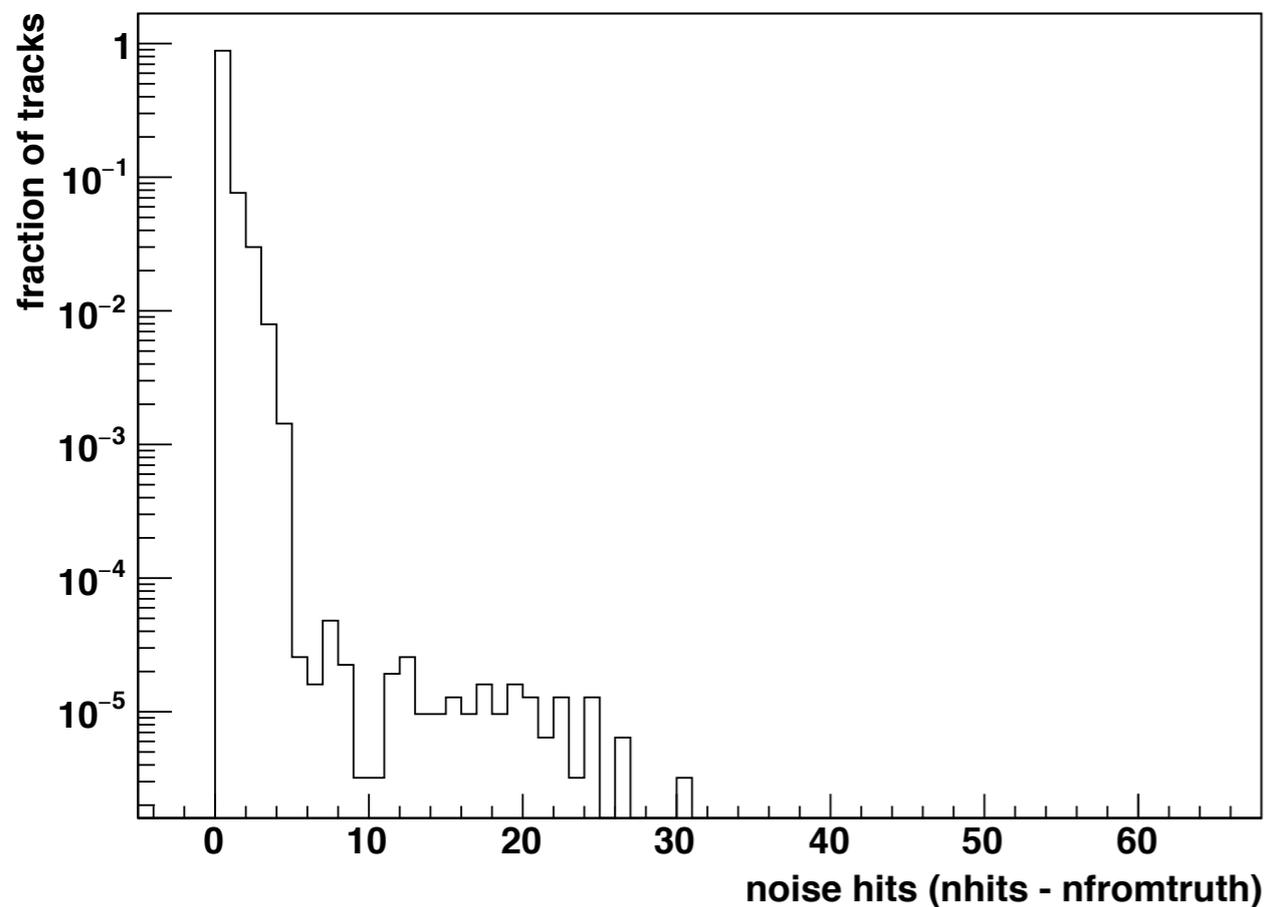
100 pions embedded in central Hijing events 60 TPC layers

Without MVTX - noise hits vs occupancy

100 pions 60 TPC
layers



100 pions embedded in
central Hijing events 60
TPC layers

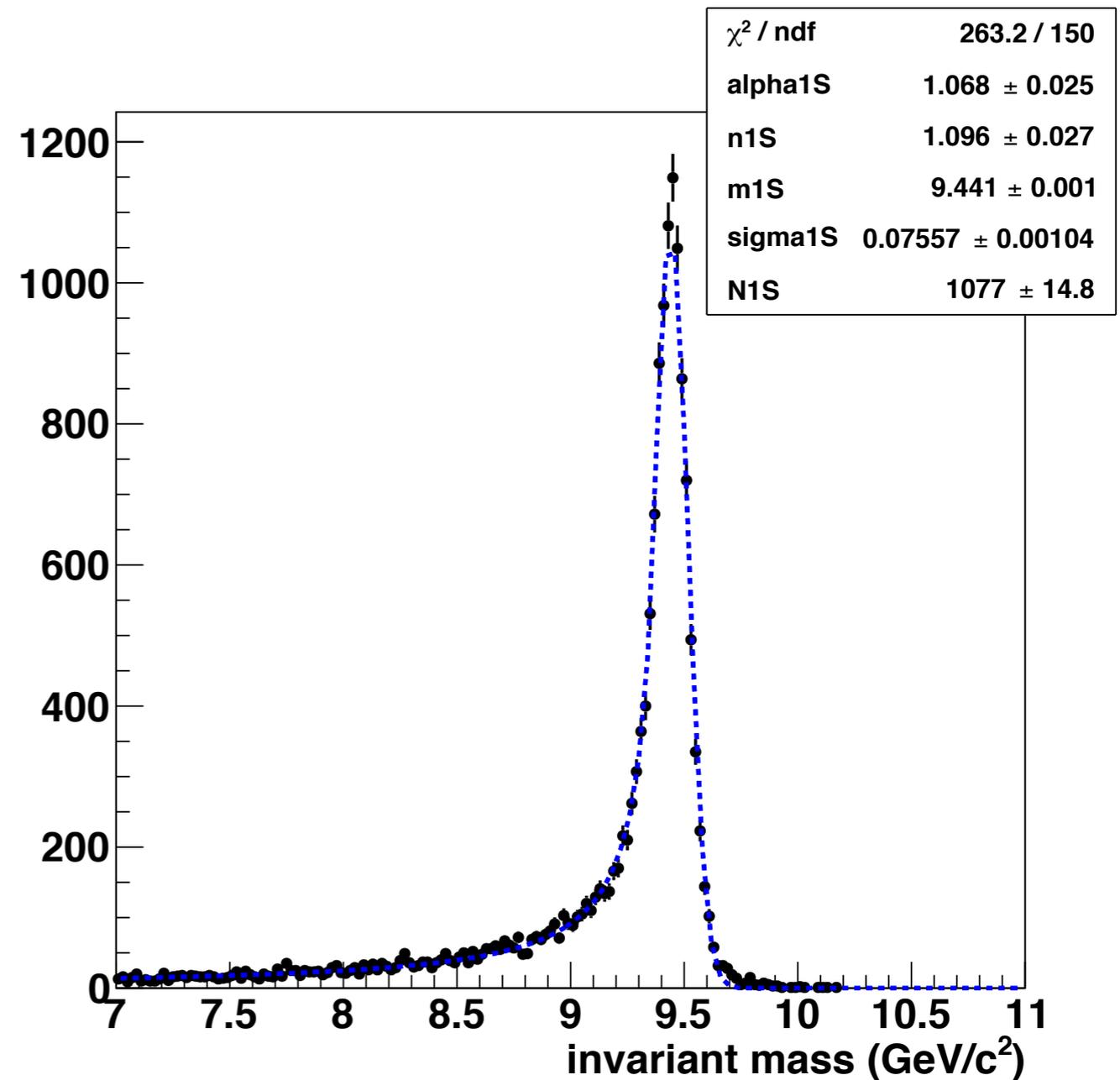
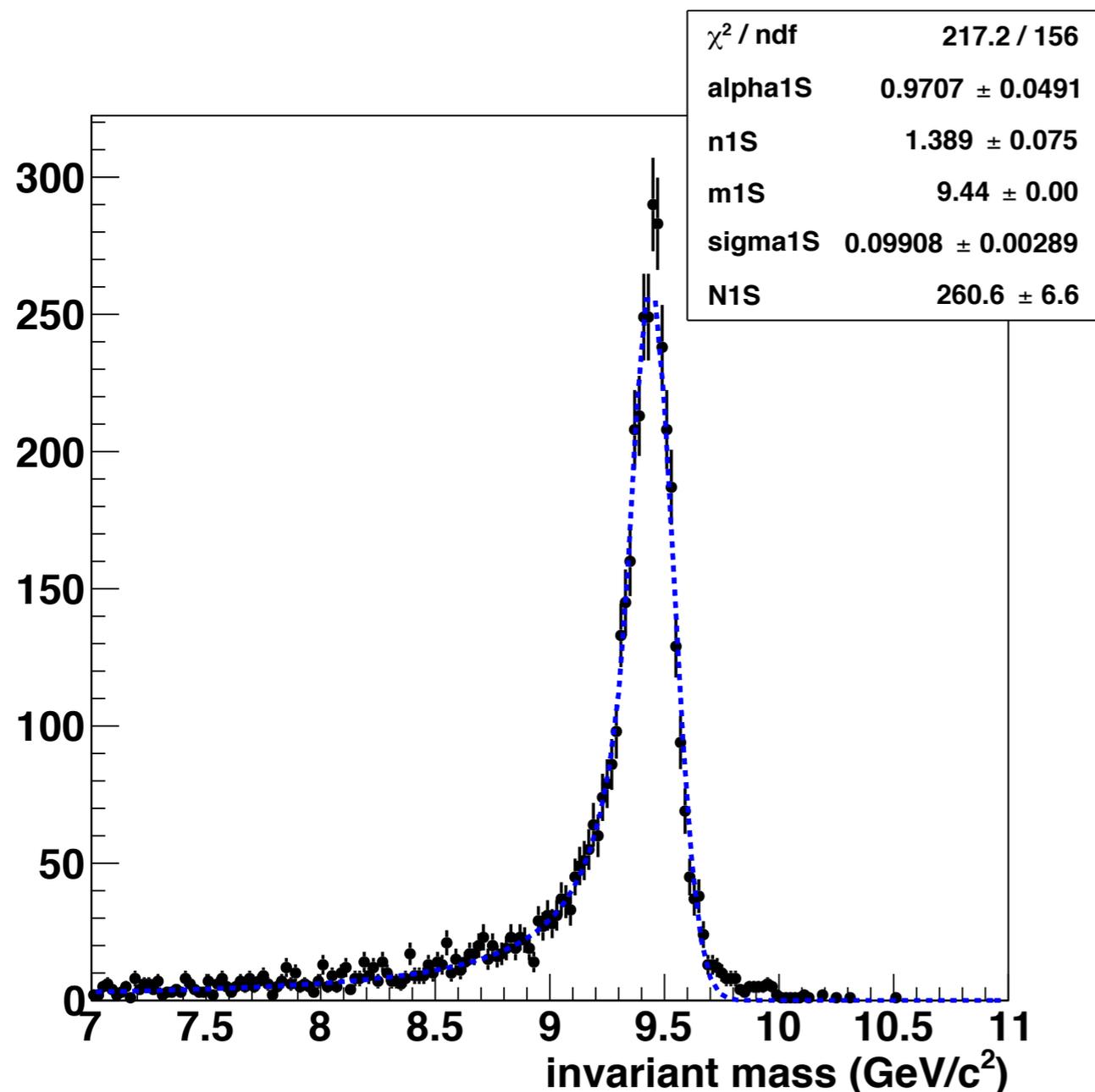


Without MVTX - Upsilon mass vs occupancy

single Upsilon 60 layer TPC

$|Z| = 0, |y| < 1.1$

$\sigma = 76 \pm 1 \text{ MeV}$



Upsilon embedded in central
Hijing 60 layer TPC

$Z = 0, y < 1.1$

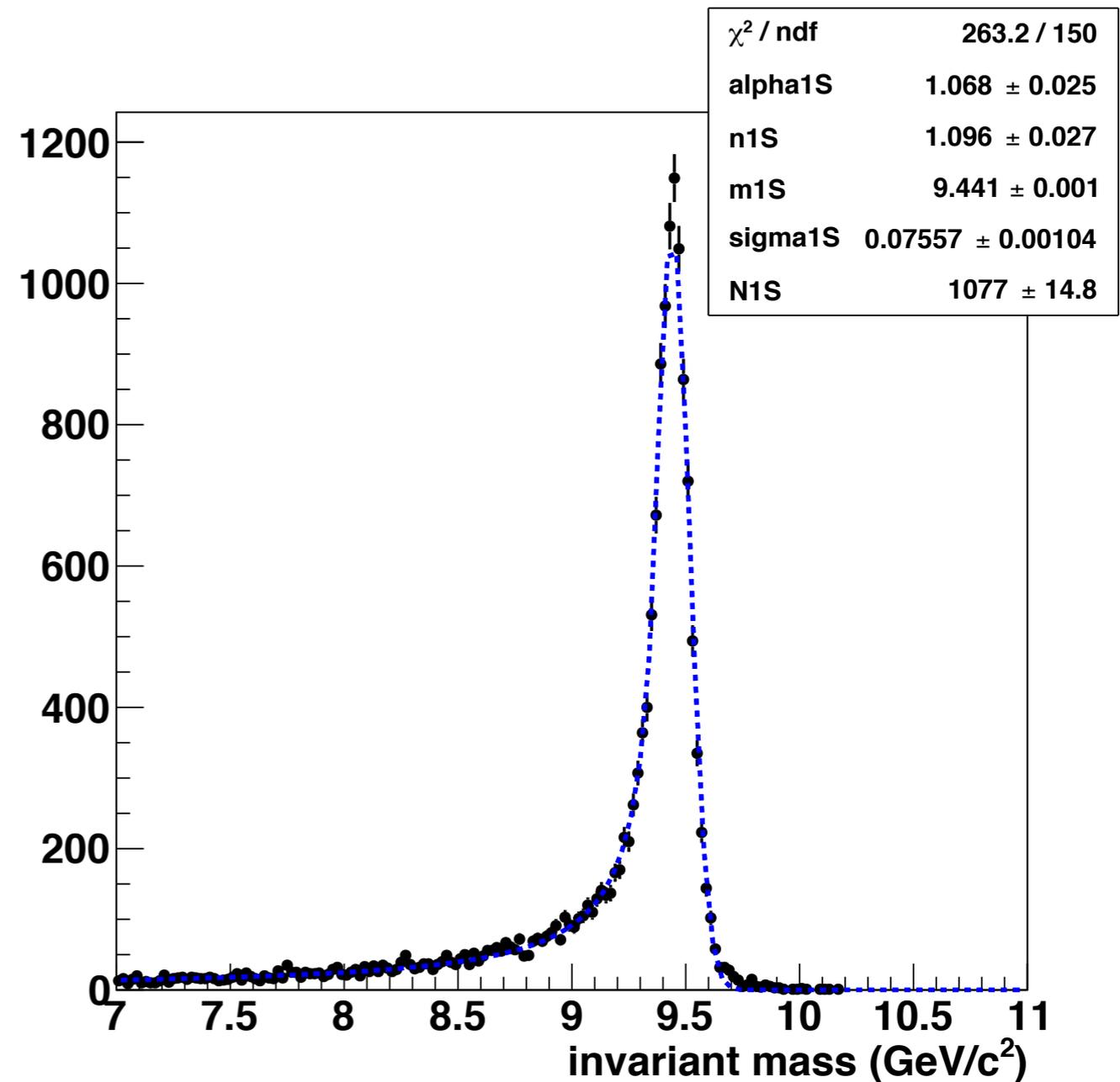
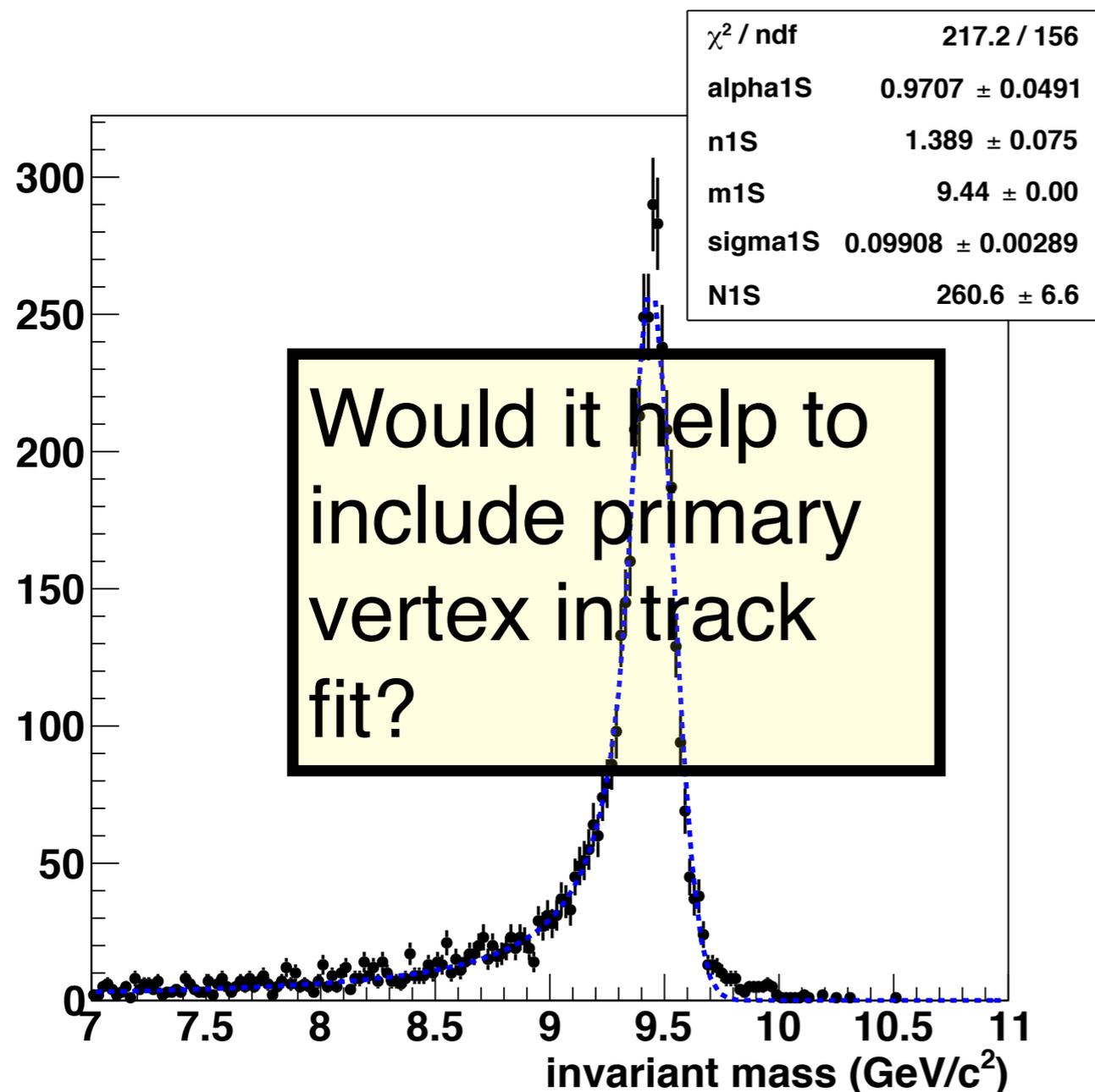
$\sigma = 99 \pm 3 \text{ MeV}$

Without MVTX - Upsilon mass vs occupancy

single Upsilon 60 layer TPC

$|Z| = 0, |y| < 1.1$

$\sigma = 76 \pm 1 \text{ MeV}$

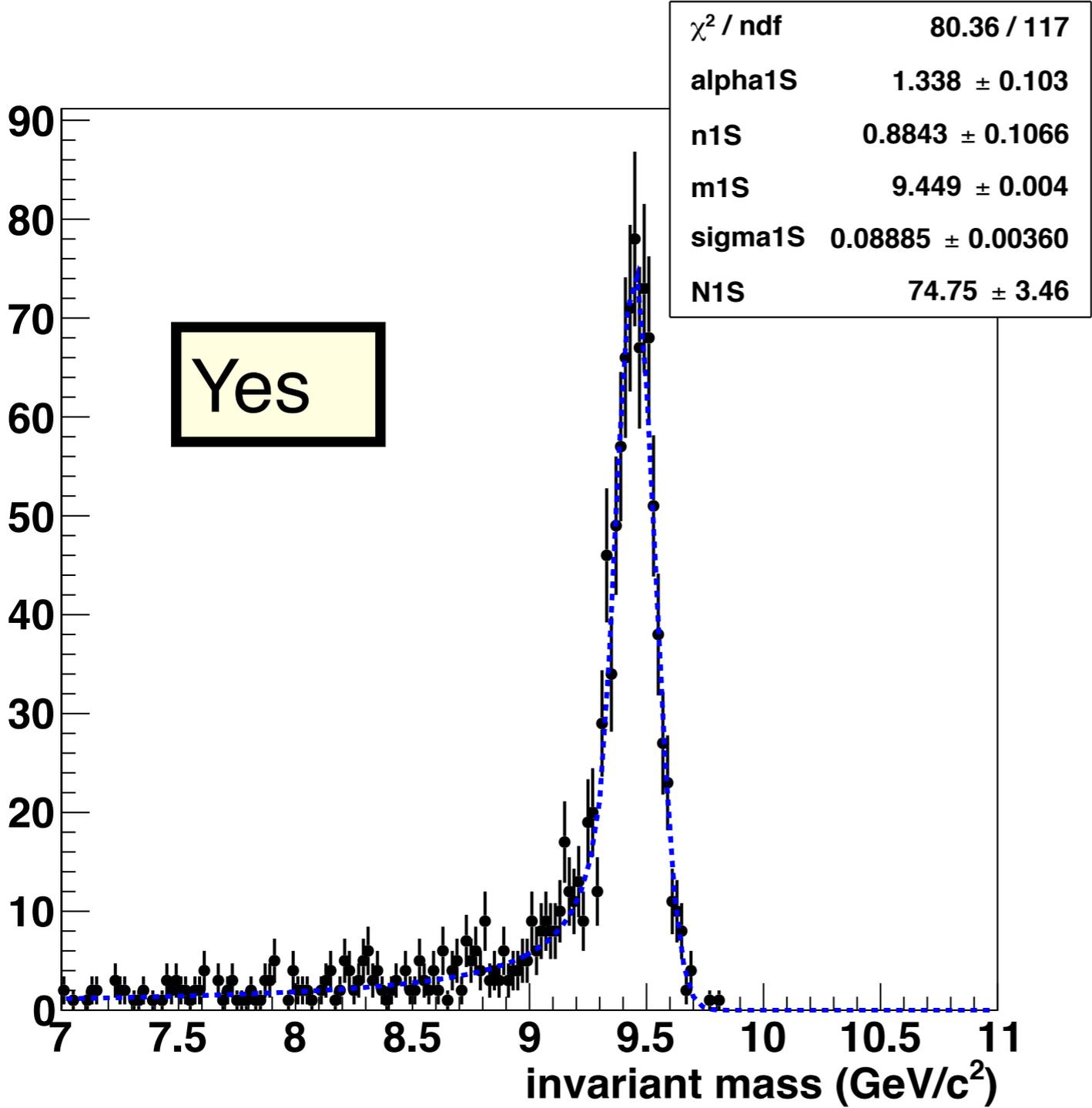


Upsilon embedded in central Hijing 60 layer TPC

$Z = 0, y < 1.1$

$\sigma = 99 \pm 3 \text{ MeV}$

Without MVTX - embedded Upsilon, event vertex in fit



Upsilon mesons embedded in
central Hijing 40 layer TPC
 $Z = 0, y < 1.1$
 $\sigma = 89 \pm 3.5 \text{ MeV}$

Summary and what next

We have detailed Geant 4 models of the MVTX and INTT ladders.
The TPC Geant 4 model is still evolving.

The tracking software upgrade is ongoing, but already very successful.

- The Upsilon mass resolution is greatly improved over the helical Hough model we used initially - detector mass is handled better.
- Performance in high occupancy events ($b = 0-4$ fm) is very encouraging.

Future work:

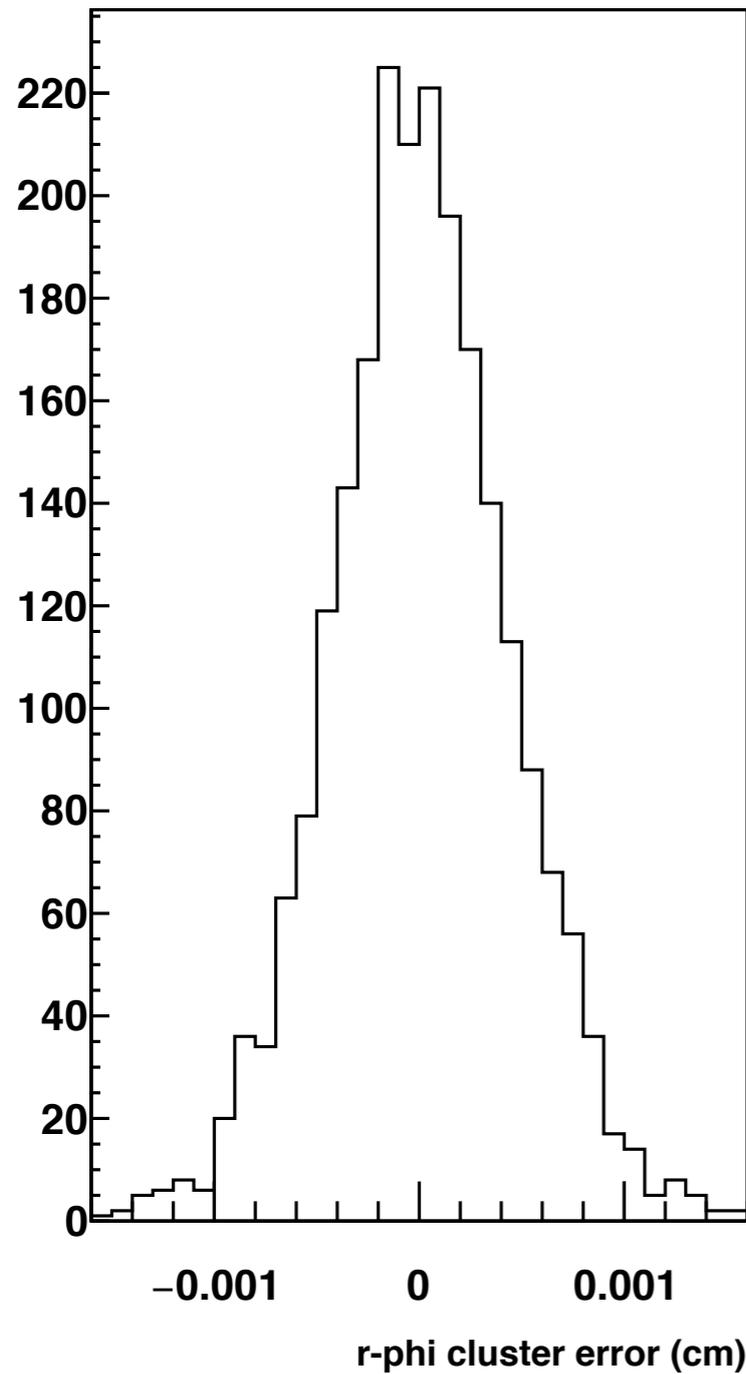
- Replace the Hough/Kalman track seeding stage with an improved pattern recognition algorithm. Track seed finding is critical to efficiency!
- TPC simulation improvements are in progress.
- Implement real initial vertex finding (currently we cheat)
- Multi-vertexing
 - Multiple events per crossing
 - secondary vertices
- Iterative tracking - efficiency, ambiguity resolution,
- Diagnostic toolkit development

Backups

With MVTX - Cluster $r\phi$ resolution

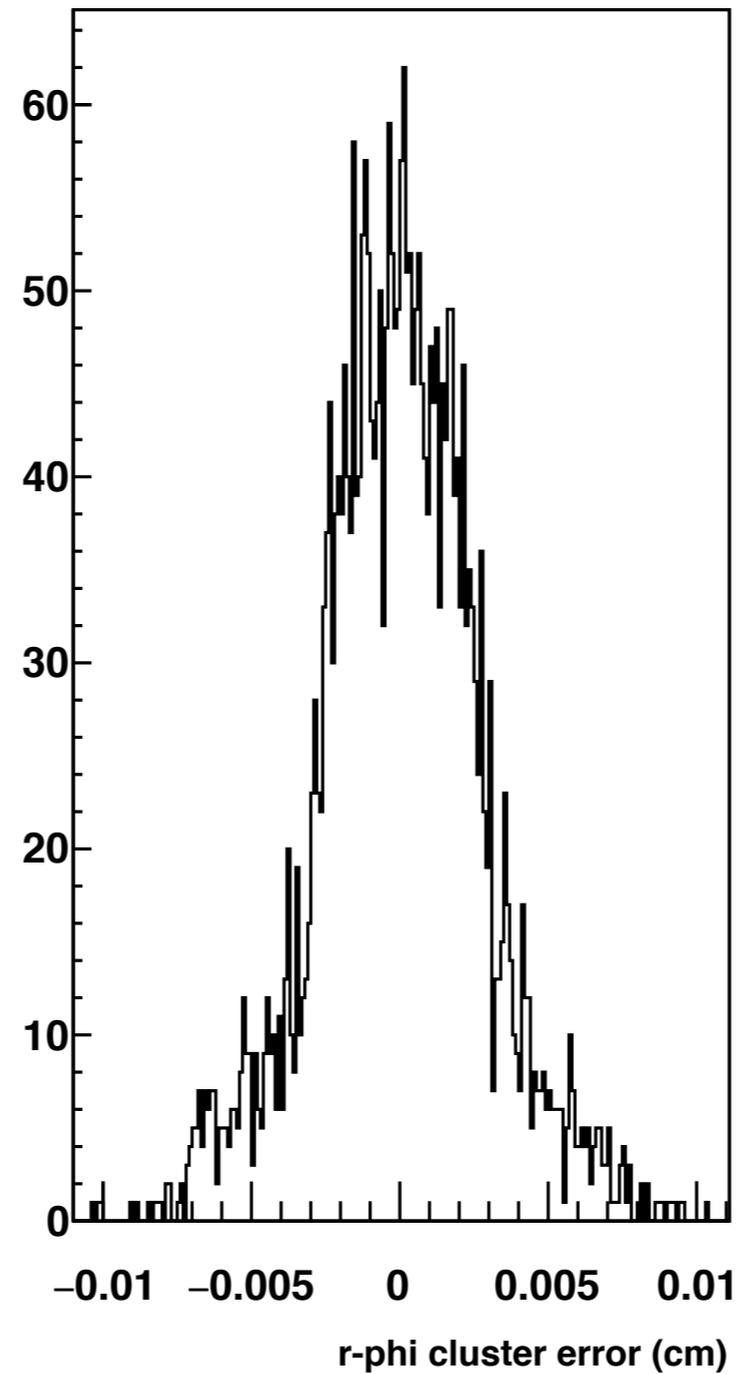
MAPS clusters

RMS $4.5 \mu\text{m}$



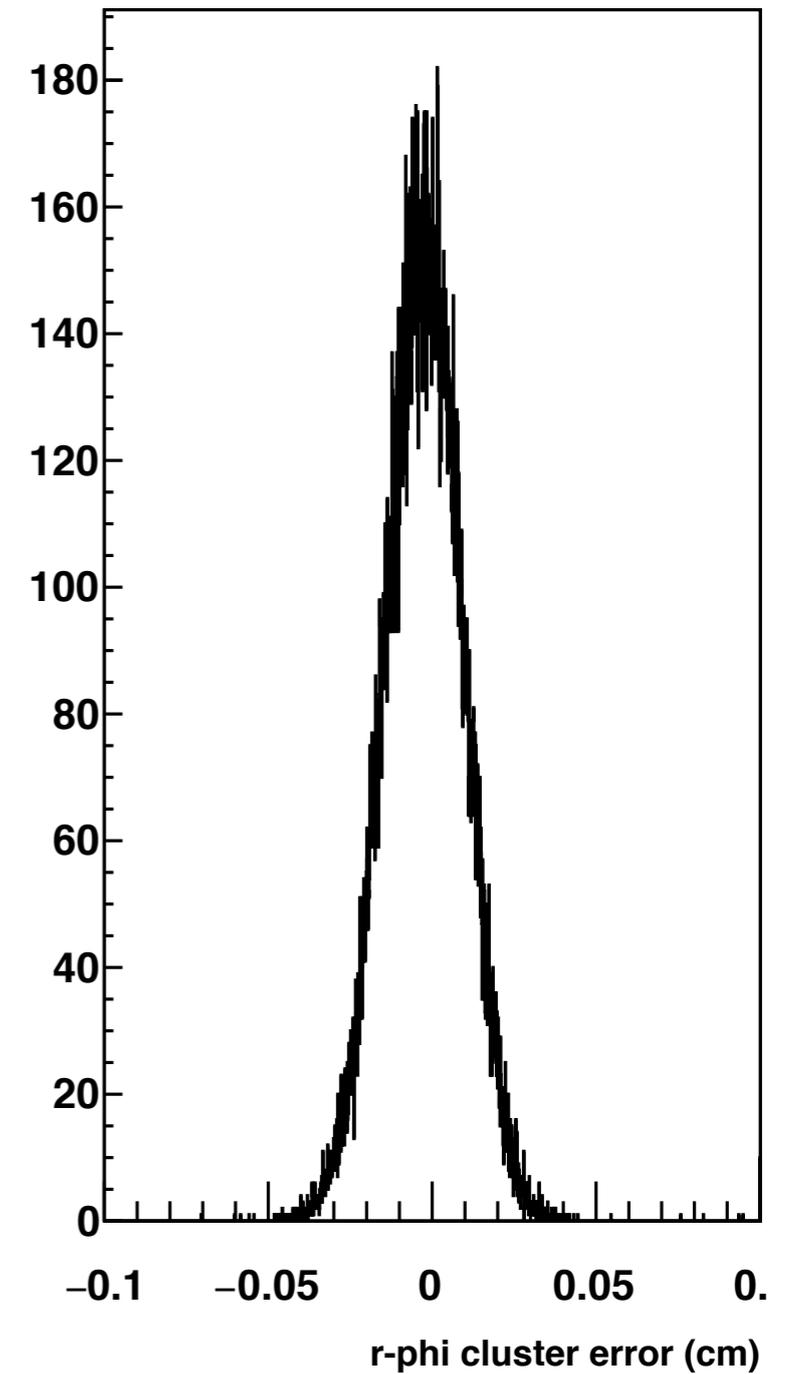
INTT clusters

RMS $27.5 \mu\text{m}$



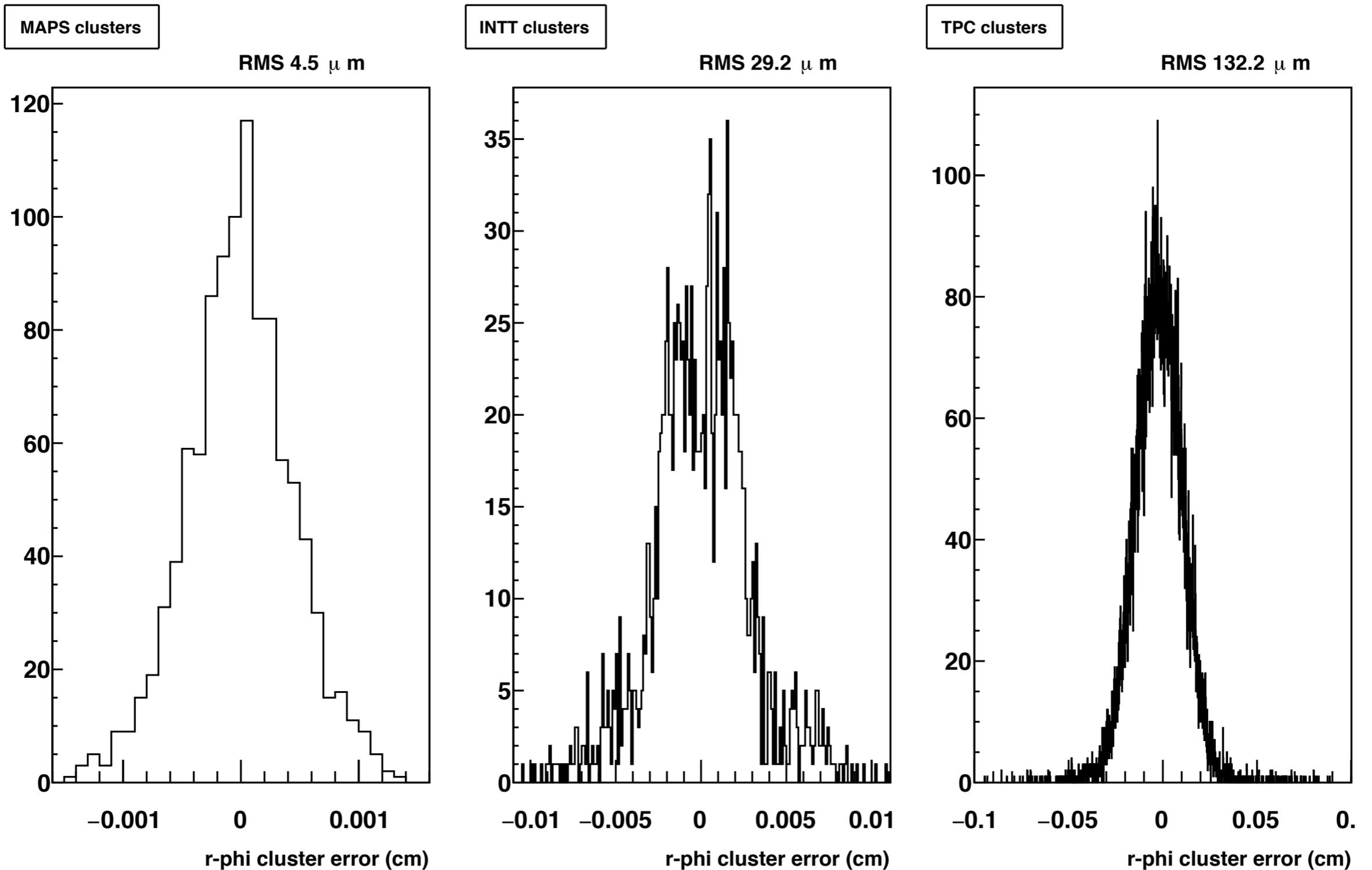
TPC clusters

RMS $118.4 \mu\text{m}$



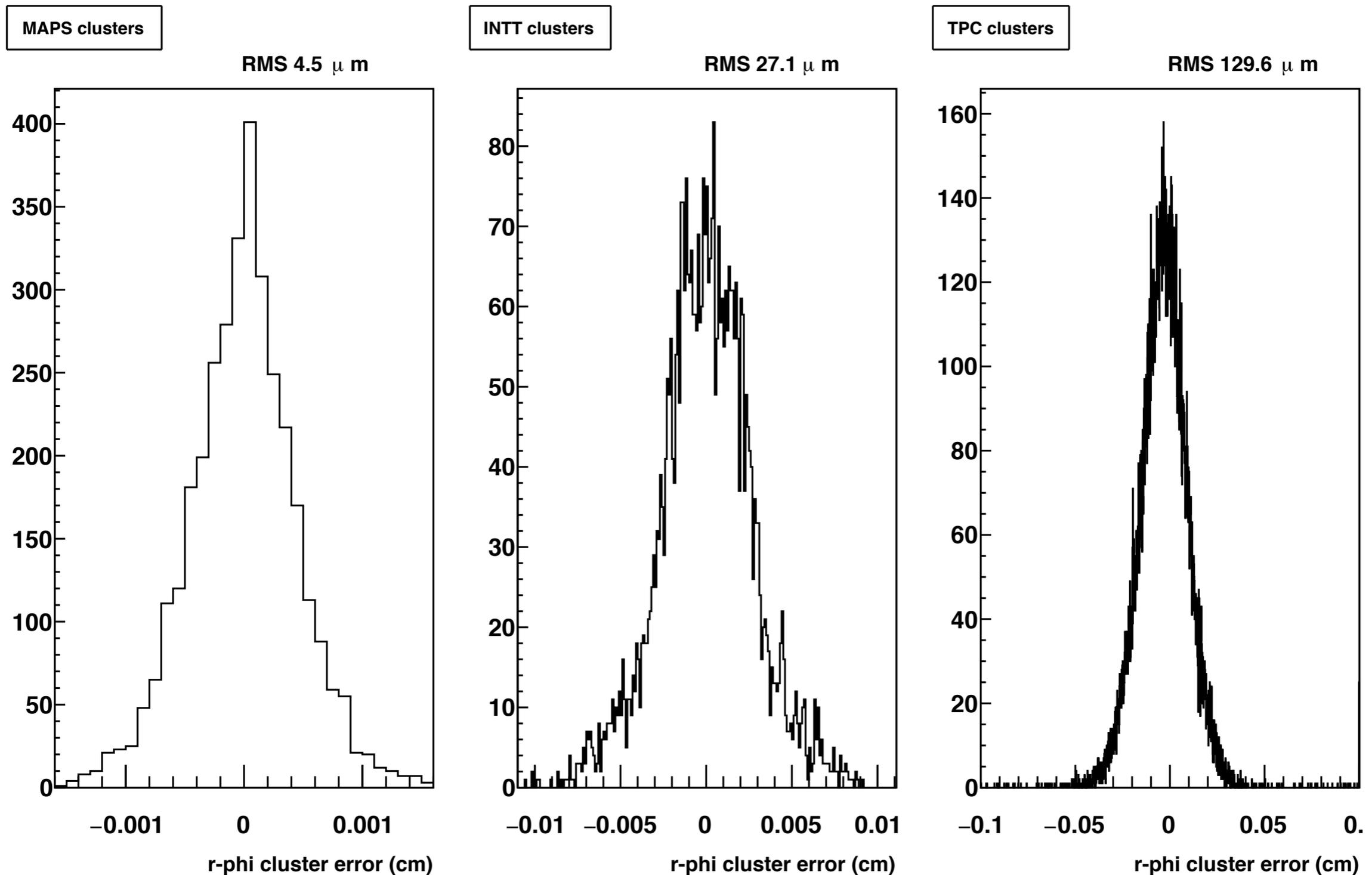
100 pions 60 TPC layers

With MVTX - Cluster $r\phi$ resolution



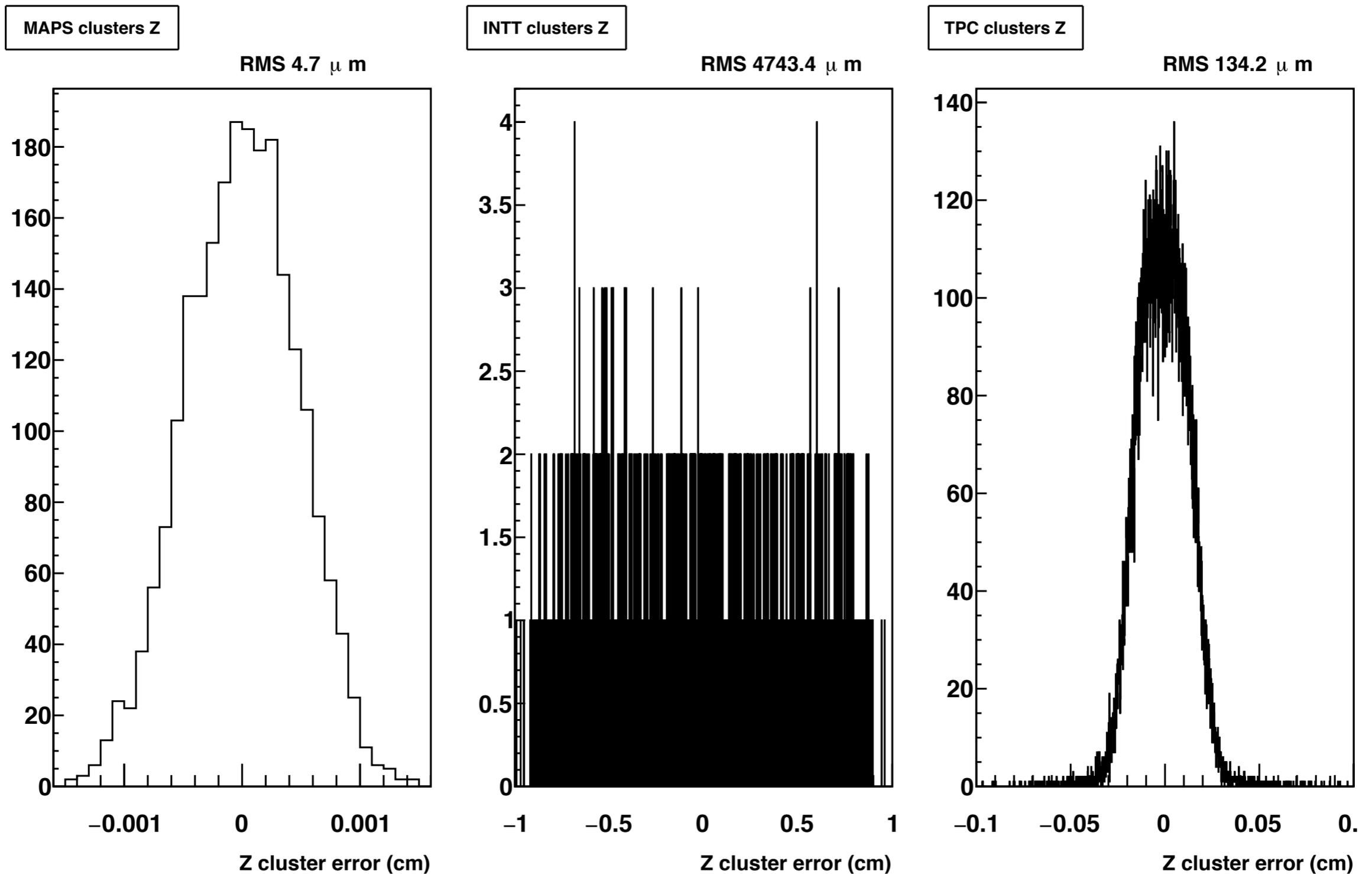
100 pions embedded in central Hijing events
60 TPC layers

With MVTX, TPC40 - Cluster $r\phi$ resolution



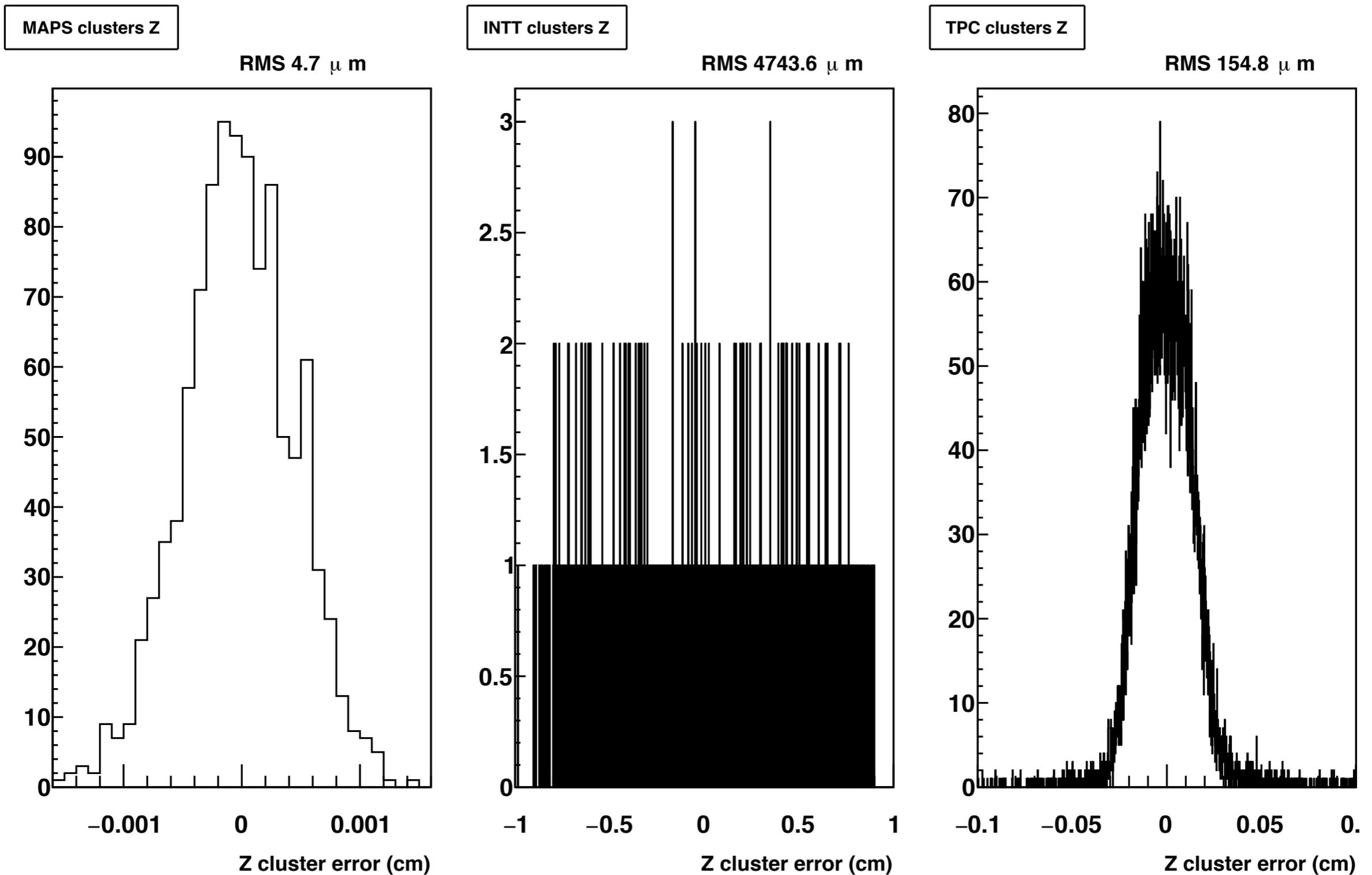
100 pions 40 TPC layers

With MVTX - Cluster Z resolution



100 pions

With MVTX - Cluster Z resolution



100 pions embedded in central Hijing events